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ABSTRACT

Five units on welding are presented in this teacher's guide. The units are the following: introduction to oxyacetylene welding, oxyacetylene welding positions and applications, use of the cutting torch, introduction to shielded metal arc welding, and welding joints and positions. Each instructional unit generally contains eight components: performance objectives; an outline of minimum instructor and student activities to accomplish unit objectives; information sheets presenting basic unit content; transparency masters; job sheets which outline skills to be achieved; student assignment sheets related to the unit information sheets (answer sheets are provided); and objective tests with answer sheets. (JH)

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GENERAL MECHANICAL REPAIR

WELDING

Volume 2 Teacher's Guide

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
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FOREWORD

This publication is one part of the instructional materials students in General Mechanical Repair. These instructional materials were developed as a result of a project funded by the Texas Education Agency to the Occupational Curriculum Laboratory at East Texas State University. The materials were developed with the assistance of General Mechanical Repair instructors across the state.

This publication can provide instruction for the skills to be acquired for entry level into various occupations in the General Mechanical Repair cluster. These materials can also provide a better means of communication in classroom instruction. To accomplish this, both teacher and student guides are printed.

The teacher's guide includes objectives, suggested activities, references, information sheets, assignments, job sheets, tests, and answer sheets.

Student manuals include the objectives, information sheets, assignments, job sheets, and tests so that the student may follow the instruction or add additional job-related information.

Every effort has been made to make this publication basic, readable, and by all means, usable. Three vital areas of instruction (motivation, personalization, and localization) cannot be included in this publication and will have to be provided by the instructor. Only then will this publication become a meaningful part of the teaching-learning process.

USE OF THE INSTRUCTIONAL UNITS

The welding units cover certain instructional areas in the classroom program. Each unit includes most or all of the basic components of a unit of instruction: performance objectives, suggested activities, information sheets, assignment sheets, job sheets, transparency masters, unit tests, and answers to the unit tests. Units are planned for more than one classroom period of instruction.

Careful study of each instructional unit will enable the teacher to determine:

- A. The amount of material that can be covered in each class period
- B. The skills that must be demonstrated
- C. The supplies and equipment needed for skill performance
- D. The amount of classroom time needed for teacher demonstration and student practice
- E. Supplementary materials that must be ordered
- F. Any resource personnel who must be contacted

The specific components of an instructional unit perform the following functions.

OBJECTIVES

Each unit of instruction is based on performance objectives. These objectives specify the exact behaviors the student will be exhibiting, thus providing students with a sense of direction.

Performance objectives are stated in two forms. The unit objectives state the materials to be covered in the unit of instruction and how the student will handle the material. Specific objectives state the types of performance the student will be doing to satisfy the unit objective.

A classroom discussion should follow immediately after the students read the objectives so that any questions concerning the performances expected of the student can be answered.

SUGGESTED ACTIVITIES

Each unit of instruction has a suggested activities sheet outlining steps to follow in accomplishing specific objectives.

Instructor. Duties of the instructor will vary from unit to unit, but the following are minimum activities for the instructor:

1. Provide students with objectives, information, assignment, and/or job sheets
2. Discuss objectives and information sheets
3. Make transparencies
4. Demonstrate procedures outlined on job sheets (when included)
5. Give test

Any additional instructional activities and teaching methods to aid students in accomplishing the objectives are strongly encouraged.

Student. Student activities are listed to help the student achieve the objectives of the unit.

INFORMATION SHEET

Information sheets provide content essential for meeting the cognitive requirements of the unit. These sheets provide an excellent guide for presenting required explanations necessary to develop the skills specified in the unit objective.

Students should read the information sheets before the information is discussed in class. Students are encouraged to make any additional notes on the information sheets to help them in their learning process.

TRANSPARENCY MASTER

Transparency masters provide information in a special way. Transparencies may present new information or they may reinforce information presented in the information sheets. These are particularly effective when identification is necessary.

Make the transparencies from the masters and place them in your notebook ready for immediate use.

Copies of transparency masters can be made and used as student handouts to supplement the material contained in the information sheet.

JOB SHEET

Job sheets are an integral part of each unit of instruction. The instructor should be able to demonstrate the skills outlined in the job sheets. Procedures specified in the job sheets give direction to the skill being taught, and allow both student and teacher to check student progress in performing the skill. Job sheets provide a ready outline to students and furnish to potential employers a picture of the types of skills being taught.

ASSIGNMENT SHEETS

Assignment sheets give direction to study and furnish activities which provide application of the material contained in the information sheet. These may be given to the student for completion in class or used for homework assignments. Answer sheets are provided for checking student progress.

UNIT TEST

Unit test questions have been constructed to measure student achievement of each specific objective listed on the objective sheet. Individual test items may be pulled out to be used as short tests to determine student achievement of a particular objective. This kind of testing may be used as a daily quiz and will help the teacher spot difficulties being encountered by students in their efforts to accomplish the unit objective.

ANSWERS TO UNIT TEST

Test answers are provided for each unit. These may be used by the teacher and/or student for checking student achievement of the objectives.

PERSONALIZING AND LOCALIZING INSTRUCTIONAL UNITS

Carefully review each instructional unit before using in the classroom. In reviewing the units, you may find it necessary to localize and personalize the material based upon the needs of your students.

Some of the ways of supplementing units include the use of audio-visuals, attention-getters, field trips, resource personnel, games and simulations, case studies,

peer teaching, role-playing, and personal experiences of both the teacher and students.

Various methods may be used in localizing a unit of instruction. You may wish to apply units of instruction to the local community, add additional materials from newspapers and magazines, invite local resource people, and arrange for field trips.

In personalizing a unit of instruction, you may want to make the course content relevant to home and/or work situations. You may wish to involve students in the planning of the unit by using their own personal experiences. Having students involved in the teaching of some of the materials is sometimes an effective example of peer teaching.

Remember that as an instructor, you may wish to add any objectives to the units of instruction based on the individual needs of the student. If this procedure is followed, you must add the corresponding information in the information sheet, add any assignment or job sheets as deemed necessary, and construct a corresponding unit test item.

EVALUATING INSTRUCTIONAL UNITS

An evaluation form is included at the end of each unit for your convenience in evaluating the use of the material. Your time and honesty in evaluating the units will provide the Occupational Curriculum Laboratory the information necessary to revise and update the publication which will, in turn, give teachers across the state the best instructional materials possible.

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I	INTRODUCTION TO OXYACETYLENE WELDING
II	OXYACETYLENE WELDING POSITIONS AND APPLICATIONS
III	USE OF THE CUTTING TORCH
IV	INTRODUCTION TO SHIELDED METAL ARC WELDING
V	WELDING JOINTS AND POSITIONS

UNIT I

INTRODUCTION TO OXYACETYLENE WELDING

UNIT OBJECTIVE

After completion of this unit, the student will be able to discuss the history of oxyacetylene welding, identify each of the parts of the welding equipment, and demonstrate the ability to safely set up, light, adjust, and operate the oxyacetylene welding equipment in the proper sequence. This knowledge will be evidenced through demonstration and by successfully completing a unit test.

SPECIFIC OBJECTIVES

After completion of this unit the student will be able to:

1. Discuss the history of oxyacetylene welding.
2. Point out the correct safety rules to follow when oxyacetylene welding.
3. Name each part of the oxyacetylene welding equipment.
4. Name each of the oxyacetylene welding flames.
5. Demonstrate the ability to:
 - a. Set up oxyacetylene equipment for welding.
 - b. Turn on, light, and adjust the welding torch, form a weld puddle, and turn off the torch.
 - c. Produce the types of welding flames used in welding.

UNIT I

INTRODUCTION TO OXYACETYLENE WELDING

SUGGESTED ACTIVITIES

- I. Instructor
 - A. Provide students with objective sheet
 - B. Provide students with information sheets and job sheets
 - C. Make transparencies
 - D. Discuss unit and specific objectives
 - E. Discuss information sheets
 - F. Show and discuss transparencies
 - G. Discuss and demonstrate procedures outlines in the job sheets
 - H. Have students repeat job sheet procedures in front of class
 - I. Give test
- II. Students
 - A. Read objectives
 - B. Study information sheet and ask questions
 - C. Demonstrate the ability to accomplish the procedures outlined in the job sheets
 - D. Take test

INSTRUCTIONAL MATERIALS

- I. Included in this unit:
 - A. Objective sheet
 - B. Information sheets
 - 1. Information Sheet #1--Introduction to Oxyacetylene Welding

2. Information Sheet #2--Equipment
3. Information Sheet #3--Welding Flames

C. Transparency masters

1. TM-1--Oxyacetylene Welding Equipment
2. TM-2--Oxyacetylene Welding Flames
3. TM-3--Look Before You Light
4. TM-4--Don't Pick Up Hot Metal with Gloves-Use Pliers

D. Job Sheets

1. Job Sheet #1--Set up Oxyacetylene Equipment for Welding
2. Job Sheet #2--Turn on, Light, and Adjust the Welding Torch, Form a Weld Puddle, and Turn Off the Torch
3. Job Sheet #3--Produce the Types of Welding Flames Used in Welding

E. Test

F. Answers to Test

II. References:

- A. Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. Modern Welding. South Holland, Illinois: The Goodheart-Wilcox Co., Inc., 1970.
- B. Little, Richard L. Welding and Welding Technology. New York, N.Y.: McGraw-Hill Book Company, 1973.
- C. Pender, James A. Welding. Toronto, New York: McGraw-Hill Book Company, 1968.

UNIT I

INTRODUCTION TO OXYACETYLENE WELDING

INFORMATION SHEET #1--INTRODUCTION TO
OXYACETYLENE WELDING

I. History

- A. Acetylene gas was first found in a free state by Sir Humphry Davy in 1815.
- B. Acetylene was not used commercially until 1892 when it was produced by mixing calcium carbide with water.
- C. Production of acetylene was done in low pressure generators in early times.
- D. The present day storage of welding gases in cylinders was proven to be safer than the acetylene generators.

II. Safety

- A. Cylinders should be secured in an upright position to a wall or dolly so they cannot be knocked over.
- B. Acetylene cylinders should never be placed on their side since the acetylene gas is in a liquid state and the acetone will be drawn out when the cylinder is lying down.
- C. Stop welding when the torch is burning with a purple flame. This indicates that the acetone is being drawn out.
- D. Do not handle welding equipment with oily gloves, and do not oil the regulators.
- E. Remove dust and dirt from the valve openings by slightly opening and quickly closing cylinder valves before attaching a regulator.
- F. Release the adjusting screw on the regulator before opening the cylinder valve so that no damage will occur to the regulator or injury to the operator.
- G. Stand to one side of the regulator when opening the cylinder valve.

- H. Open valves very slowly on cylinders.
 - I. Never use acetylene at pressures above 15 PSI since it is very unstable.
 - J. Check every few days for leaks in hoses and fittings, using soapy water.
 - K. Purge lines separately before lighting the torch so that gas mixtures in lines will not cause flashback.
 - L. Have safety clothing and protection in place before lighting the torch.
 - M. Always light the acetylene before opening the oxygen on the torch.
 - N. Make sure that no person or any flammable material is in the direction of the flame when lighting and using the torch.
 - O. Do not use the oxygen in the torch to cool yourself because the oxygen will support combustion of materials that are usually not combustible.
- (Note: This could cause your clothes to burn rapidly if you caught on fire.)
- P. Know how to use fire extinguishers in the shop.
 - Q. Open the acetylene valve no more than one turn so that it may be shut off quickly in case of a fire.
 - R. Avoid welding materials that give off combustion or toxic fumes.
 - S. Provide adequate ventilation in welding areas.
 - T. Close main cylinder valves when the oxyacetylene unit is not to be in use for long periods of time.
 - U. Turn off acetylene torch valve and then the oxygen torch valve when shutting down the welding unit.
 - V. Remove extra or empty cylinders from the welding area and building when possible. (Tag cylinders as empty)
 - W. Place steel caps on all cylinders when transporting or storing them.

- X. Keep welding area neat and free from extra materials.
- Y. Avoid handling hot metal with gloves. Use pliers.
- Z. Use snug-fitting wrenches when installing or removing regulators.

UNIT I

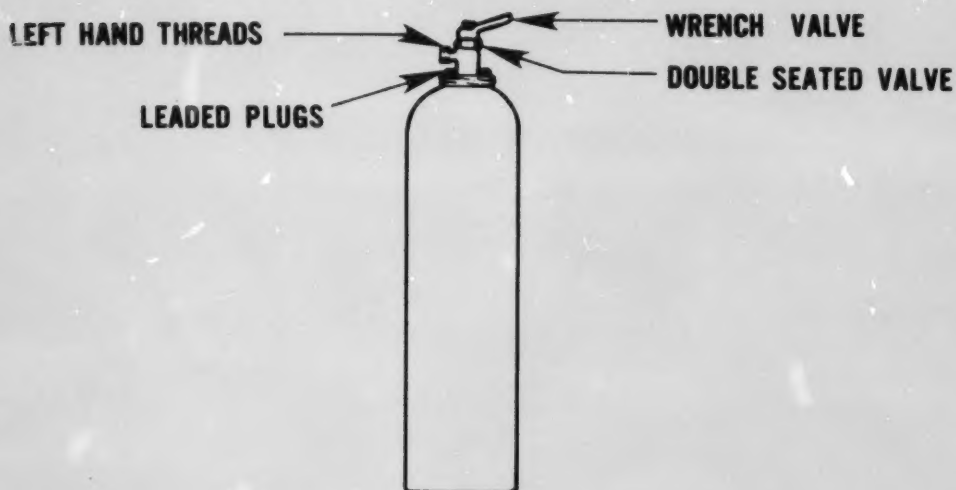
INTRODUCTION TO OXYACETYLENE WELDING

INFORMATION SHEET #2--EQUIPMENT

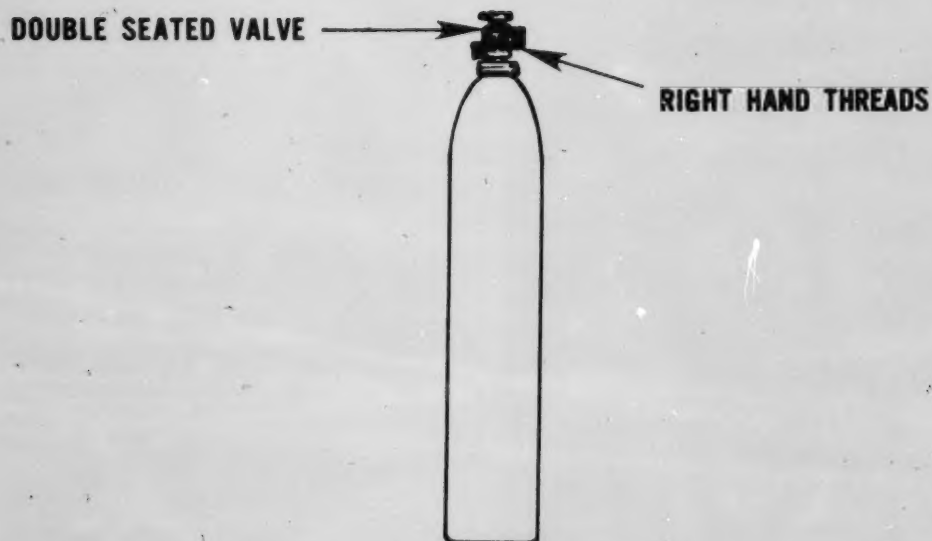
III. Oxyacetylene Welding Equipment

A. Cylinders

1. Acetylene



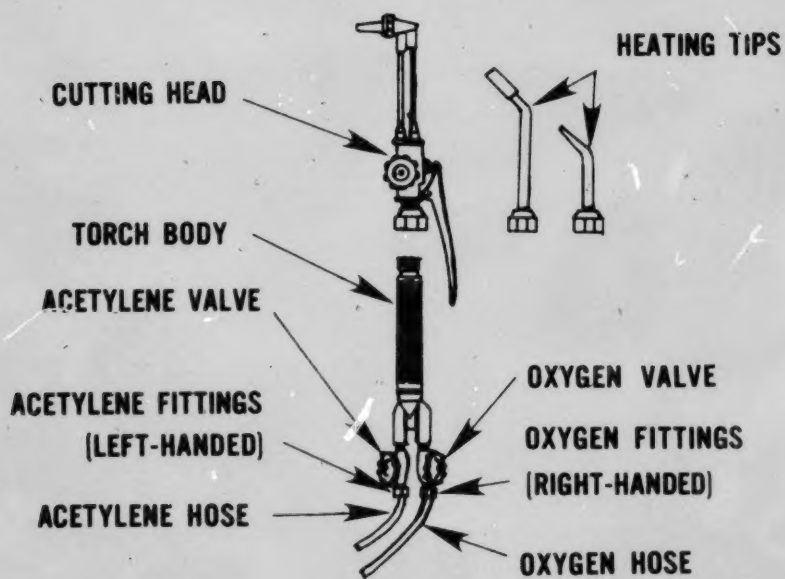
2. Oxygen



B. Cart or dolly

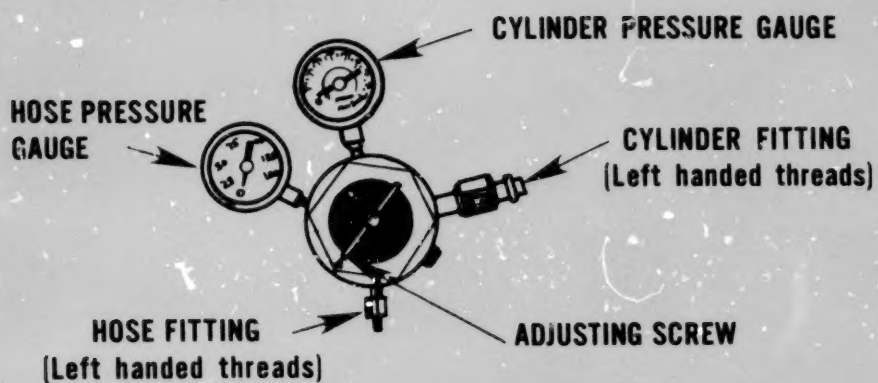


C. Torch

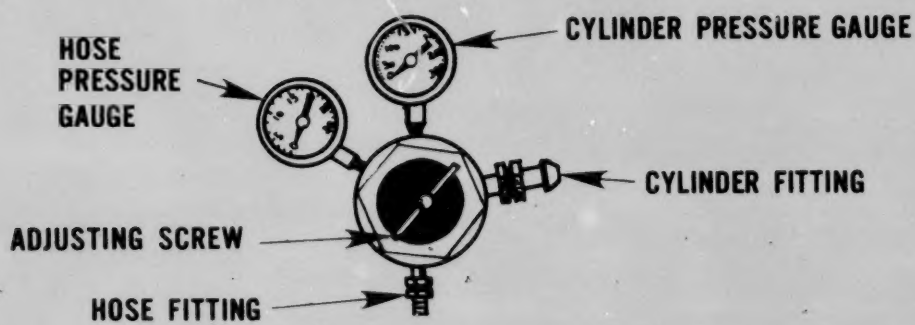


D. Regulators

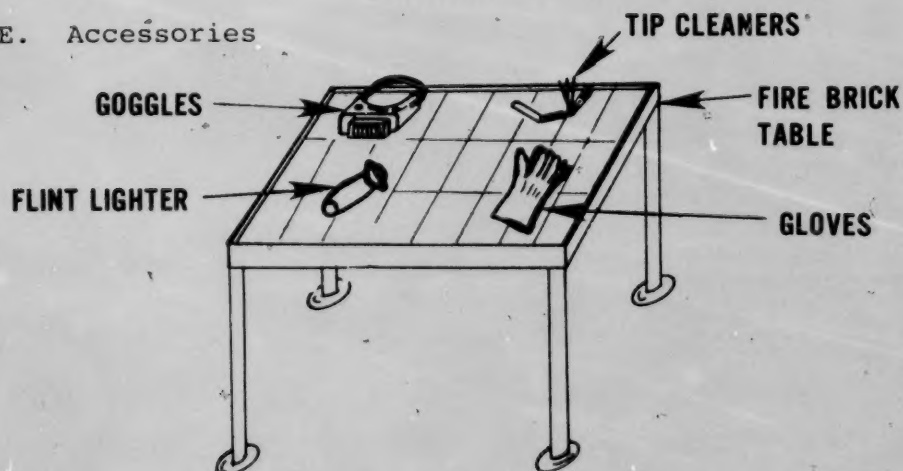
1. Acetylene



2. Oxygen



E. Accessories



UNIT I

INTRODUCTION TO OXYACETYLENE WELDING

INFORMATION SHEET #3--WELDING FLAMES

IV. Types of oxyacetylene flames

A. Carburizing

1. Uses an excessive amount of acetylene
2. Produces black smoke and a long yellow flame

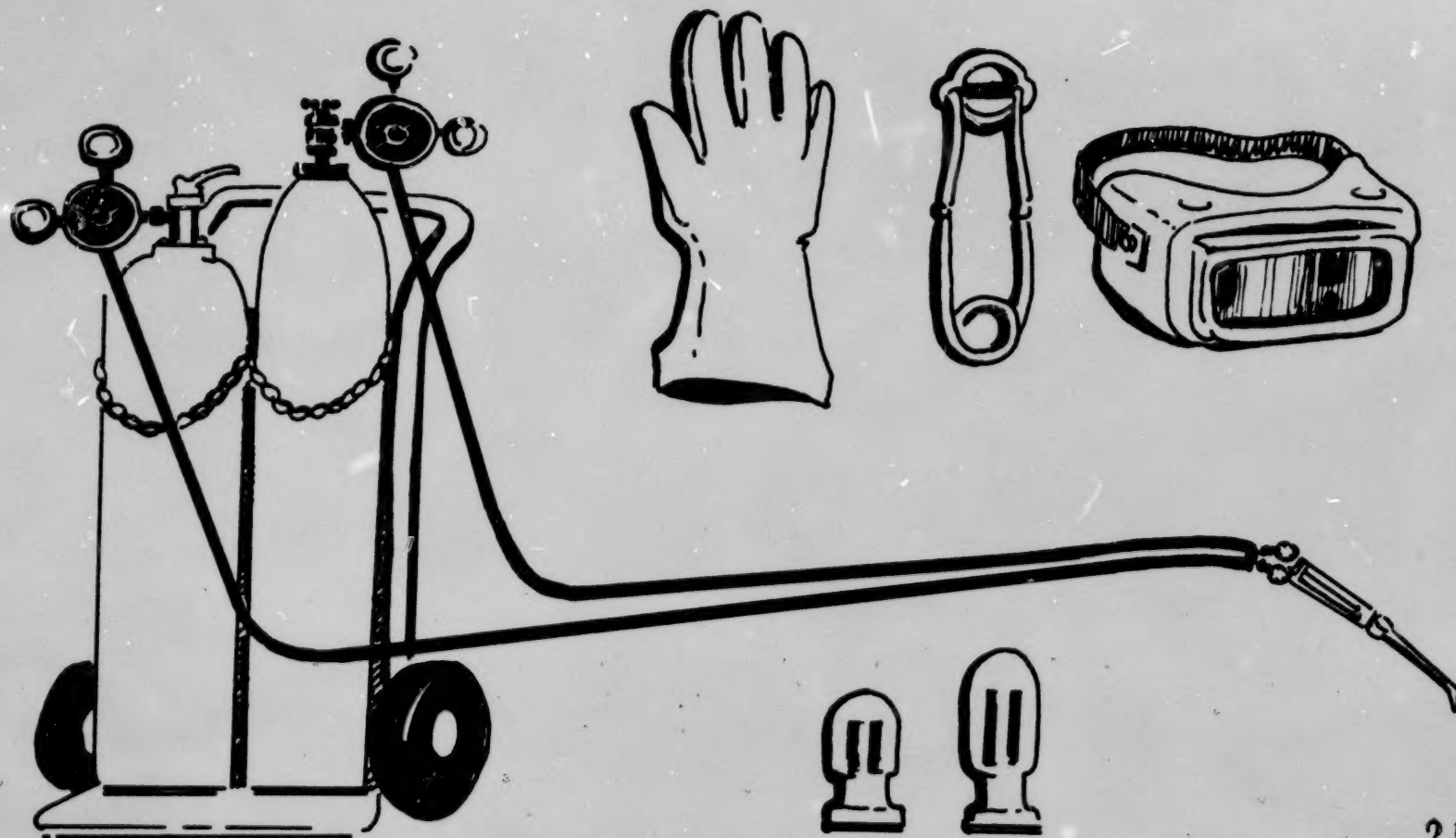
B. Neutral

1. Used for best welding results
2. Uses equal amounts of oxygen and acetylene
3. Is identified by a clear cone
4. Produces a temperature of about 6000°

C. Oxidizing

1. Uses an excessive amount of oxygen
2. Inner cone is shorter than in neutral flame
3. Inner cone appears to jump away from the tip of the torch
4. Produces hottest flame
5. Has a hissing sound

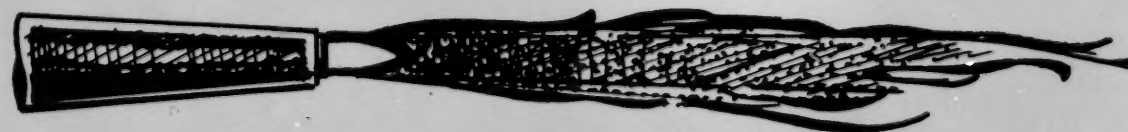
OXYACETYLENE WELDING EQUIPMENT



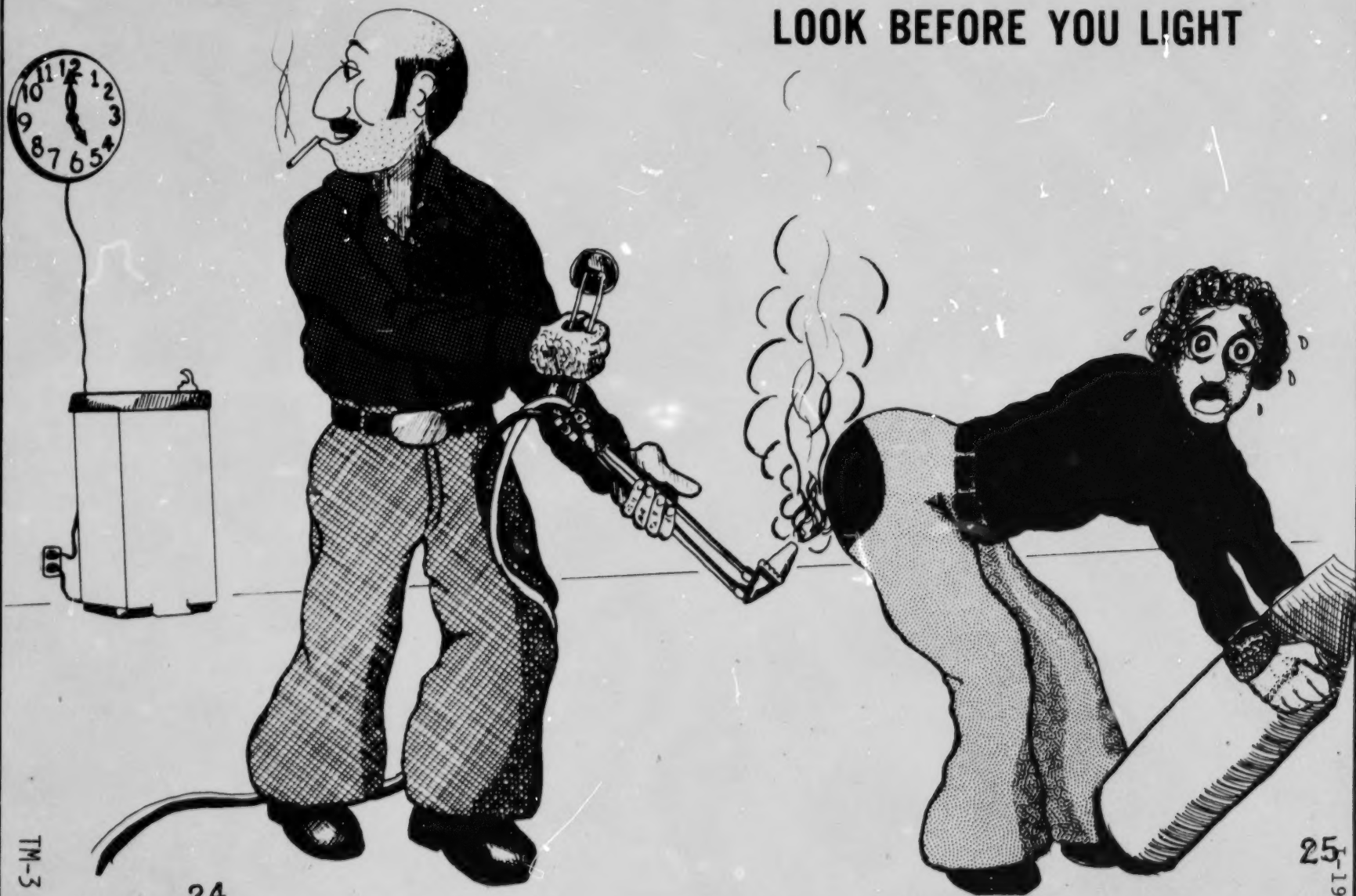
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OXYACETYLENE WELDING FLAMES



LOOK BEFORE YOU LIGHT



**DON'T PICK UP HOT METAL WITH GLOVES -
USE PLIERS**



UNIT I

INTRODUCTION TO OXYACETYLENE WELDING

JOB SHEET #1--SET UP OXYACETYLENE EQUIPMENT FOR WELDING

I. Tools, equipment, and materials required

- A. Complete oxyacetylene welding unit
- B. Gloves
- C. Lighter
- D. Goggles
- E. Coveralls
- F. Soapy water and brush
- G. 12-inch crescent wrench
- H. Oxygen and acetylene bottles
- I. Dolly or cart

II. Procedure

- A. Place bottles in dolly.

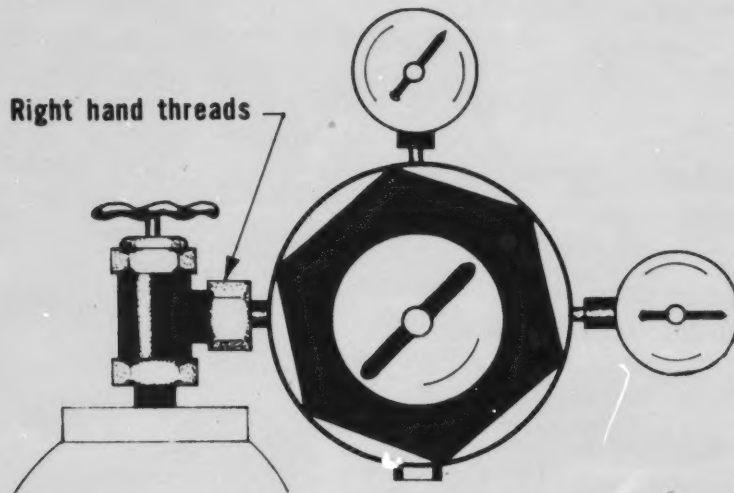
(NOTE: Fasten bottles to a wall or bench when a dolly is not available.)

- B. Remove caps from both bottles.
- C. Quickly open and close each valve.

(CAUTION: Stand to one side of the valve openings.)

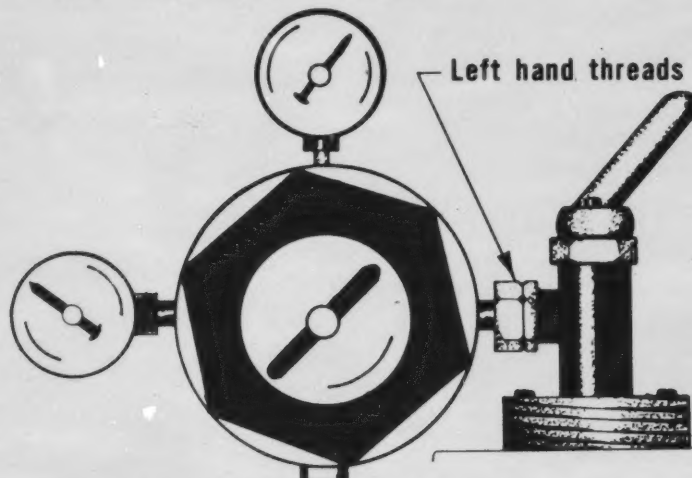
- D. Attach the oxygen regulator to the oxygen bottle.

(NOTE: This nut is smooth and has right hand threads.)



- E. Tighten the nut securely with the wrench.
- F. Open the oxygen cylinder valve very slowly until the high pressure gauge has stopped climbing.
(CAUTION: Stand to the side of the regulator.)
- G. Open the valve all the way.
- H. Attach the acetylene regulator to the acetylene cylinder.

(NOTE: This nut has a groove cut around it and has left hand threads.)



- I. Tighten the nut securely with the wrench.
- J. Open the acetylene cylinder valve slowly for one turn.

(CAUTION: Stand to the side of the regulator.)

(NOTE: If the cylinder does not have a valve, an acetylene wrench must be used.)

- K. Attach the acetylene hose to the acetylene regulator.

(NOTE: The acetylene hose is red and the fitting has left hand threads.)

- L. Tighten the winged adjusting screw enough to allow a small amount of acetylene to flow through the hose, and then loosen it.

- M. Attach the oxygen hose to the oxygen regulator.

(NOTE: The oxygen hose is green and the fitting has right hand threads.)

- N. Screw the winged adjusting screw in enough to allow a small amount of oxygen to flow through the hose, and then back the screw out.

- O. Attach the oxygen hose to the torch valve marked oxygen.

(NOTE: The hose fitting has right hand threads.)

- P. Attach the acetylene hose to the torch valve marked ACETYLENE.

(NOTE: The hose fitting has left hand threads.)

- Q. Attach a No. 1 heating tip to the torch body.

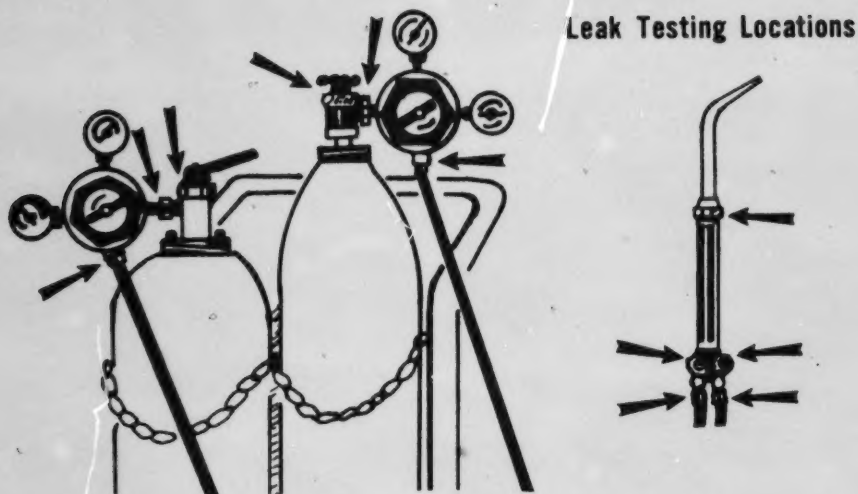
(NOTE: Hand-tighten torch tips.)

- R. Close both torch valves.

- S. Adjust the winged adjusting screw on the oxygen regulator until the low pressure gauge reaches 20-pounds pressure.

- T. Adjust the winged adjusting screw on the acetylene regulator until the low pressure gauge reaches 5-pounds pressure.

- U. Test all connections for leaks by brushing soapy water on all fittings and connections.



Leak Testing Locations

- V. Tighten any leaking connections.
- W. Close both cylinder valves.
- X. Open the acetylene torch valve until the acetylene gauges reach zero and then close the valve.
- Y. Open the oxygen torch valve until the oxygen gauges reach zero and then close the valve.
- Z. Back out both winged adjusting screws until tension is released on the regulators.
- Aa. Roll up hoses and place the torch in a secure place.
- Bb. Clean the work area and turn in tools.

UNIT I

INTRODUCTION TO OXYACETYLENE WELDING

JOB SHEET #2--TURN ON, LIGHT, AND ADJUST THE WELDING TORCH,
FORM A WELD PUDDLE, AND TURN OFF THE TORCH
PROPERLY

I. Tools, equipment, and materials required

- A. Complete oxyacetylene welding unit
- B. Gloves
- C. Lighter
- D. Goggles
- E. Coveralls
- F. Pliers
- G. Welding plate

II. Procedure

- A. Opening and lighting the oxyacetylene welding unit
 - 1. Check cylinder, regulator, and torch valves to make sure they are closed.
 - 2. Put on safety goggles, gloves, and coveralls.
 - 3. Slowly open acetylene cylinder valve one turn.
 - 4. Regulate the winged adjusting screw until the low pressure gauge reaches 5 PSI.
 - 5. Slowly open oxygen cylinder valve until pressure has stopped climbing on the high pressure gauge, and then open the valve all the way.
 - 6. Regulate the winged adjusting screw until the low pressure oxygen gauge reaches 20 PSI.
 - 7. Using the flint lighter, light the torch by opening the acetylene torch valve 1/4 turn and striking the lighter in front of the tip.
 - 8. Adjust acetylene valve until torch nearly quits smoking.

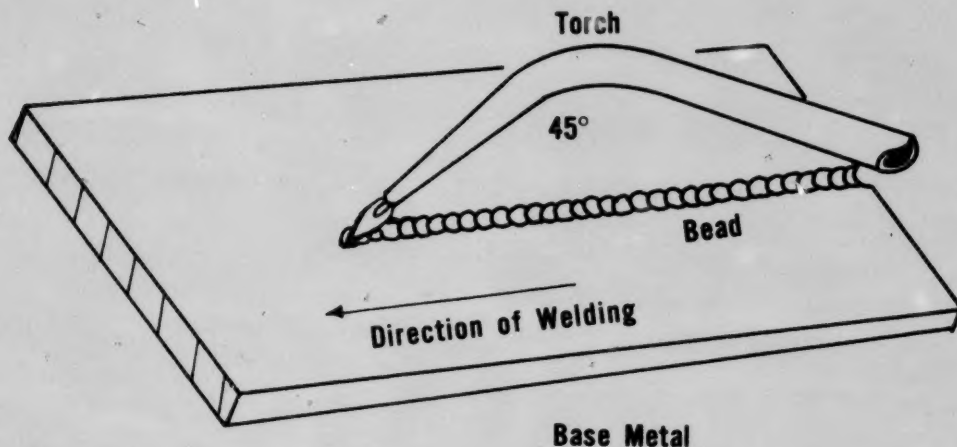
9. Open torch oxygen valve slowly until a neutral flame has been reached.

(NOTE: There should be a clear inner cone in the flame.)

B. Forming a weld puddle

1. With goggles and gloves in place, hold torch 1/4 of an inch above the welding plate on the fire brick.
2. Hold in position until the metal under the flame becomes molten and then very slowly travel down the metal in a small 1/4 of an inch circling pattern.
3. Watch for an even weld pattern behind the weld puddle.

(NOTE: A hole might appear if travel is too slow.)



4. After completing a weld puddle, close the acetylene torch valve.
5. Close the oxygen torch valve.
6. Place torch on table.

(NOTE: Make sure not to lay torch on hoses or a hot area.)

C. Shutting down the oxyacetylene welding unit

1. With both torch valves closed, shut the acetylene cylinder valve.
2. Open torch acetylene valve until both gauges have reached zero PSI.
3. Close torch acetylene valve.
4. Back the winged adjusting screw out until the tension on the regulator is released.
5. Close the oxygen cylinder valve.
6. Open the torch oxygen valve until both gauges reach zero PSI.
7. Close oxygen torch valve.
8. Back the winged adjusting screw out until the tension on the oxygen regulator is released.
9. Roll up hoses on the welding cart or dolly and place torch where it will not get knocked to the floor.
10. Clean work area and turn in tools.

UNIT I

INTRODUCTION TO OXYACETYLENE WELDING

JOB SHEET #3--PRODUCE THE TYPES OF WELDING FLAMES

I. Tools, equipment, and materials required

- A. Complete oxyacetylene welding unit
- B. Gloves
- C. Goggles
- D. Coveralls
- E. Lighter

II. Procedure

- A. Set up and adjust welding equipment to 20 PSI oxygen and 5 PSI acetylene.
- B. Light the torch.

(NOTE: This produces acetylene burning in free air.)



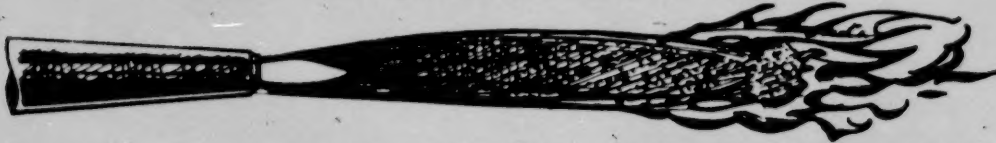
- C. Open the oxygen torch valve until a clear inner cone forms.

(NOTE: This produces a neutral flame.)



- D. Reduce the amount of oxygen.

(NOTE: This produces a carburizing flame.)



- E. Regulate the carburizing flame feather by adjusting the torch oxygen valve.

- F. Open the torch oxygen valve past the point that the neutral flame forms.

(NOTE: The inner cone shortens and a hissing sound will start when the oxidizing flame is formed.)



- G. Turn off the torch.

- H. Shut down the welding equipment.

- I. Roll up the hoses and place the torch where it will not get knocked into the floor.

- J. Clean work area and turn in tools.

UNIT I

INTRODUCTION TO OXYACETYLENE WELDING

TEST--PART 1

1. Discuss briefly the history of oxyacetylene welding.

2. Point out the correct safety rules by writing True or False for each of the following statements.
 - _____ a. Cylinders should be secured to a wall or dolly in an upright position so they cannot be knocked over.
 - _____ b. Acetylene cylinders should never be placed on their sides as the acetylene gas is in a liquid state and the acetone will be drawn out.
 - _____ c. Stop welding when the torch is burning with a yellow flame as the acetone is being drawn out.
 - _____ d. Do not handle welding equipment with oily gloves or oil the regulators.
 - _____ e. Open cylinder valves for several minutes to remove dust and dirt before attaching a regulator.
 - _____ f. Release the adjusting screw on regulator before opening the cylinder valve so no damage will occur to the regulator or injury to the operator.
 - _____ g. Stand directly in front of the regulator when opening the cylinder valve so that you can see the regulator better.
 - _____ h. Open valves very slowly on cylinders.
 - _____ i. Never use acetylene at pressures above 15 PSI because it is very unstable.

- _____ j. Check for leaks in hoses and fittings every 15 minutes with soapy water.
- _____ k. Purge oxygen and acetylene lines at the same time since it is quicker.
- _____ l. Have safety clothing and protection in place before lighting.
- _____ m. Always light the acetylene before opening the oxygen on the torch.
- _____ n. Make sure that no one or any flammable material is in the direction of the flame when lighting and using the torch.
- _____ o. Oxygen is a cooling gas and can be used to cool oneself on a hot day.
- _____ p. Know how to use fire extinguishers in the shop.
- _____ q. Open the acetylene valve several turns so that the acetylene gas is not restricted.
- _____ r. Avoid welding on materials that have combustible or toxic fumes given off.
- _____ s. Ventilation in welding areas is not necessary because smoke rises.
- _____ t. Close the main cylinder when the oxyacetylene unit is not in use for long periods of time.
- _____ u. Turn off the oxygen torch valve fast when shutting down the welding unit.
- _____ v. Leave cylinders in the welding area when empty as you should move cylinders as little as possible.
- _____ w. Place steel caps on all cylinders when transporting or storing them.
- _____ x. Keep welding area neat and free from extra materials.
- _____ y. Avoid handling hot metal with gloves.
- _____ z. Use loose-fitting wrenches when installing or removing regulators so the wrenches may be removed quickly.

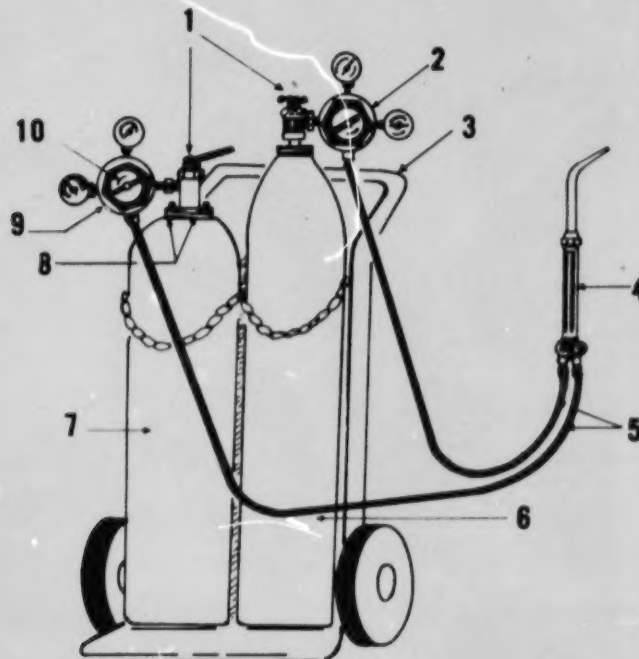
UNIT I

INTRODUCTION TO OXYACETYLENE WELDING

TEST--PART 2

3. Write the number of each part of the oxyacetylene welding equipment by its correct name.

- ____ a. Oxygen cylinder
- ____ b. Acetylene cylinder
- ____ c. Cylinder valves
- ____ d. Winged adjusting nut
- ____ e. Cart
- ____ f. Leaded plugs
- ____ g. Oxygen regulator
- ____ h. Acetylene regulator
- ____ i. Torch body
- ____ j. Hoses



UNIT I

INTRODUCTION TO OXYACETYLENE WELDING

TEST--PART 3

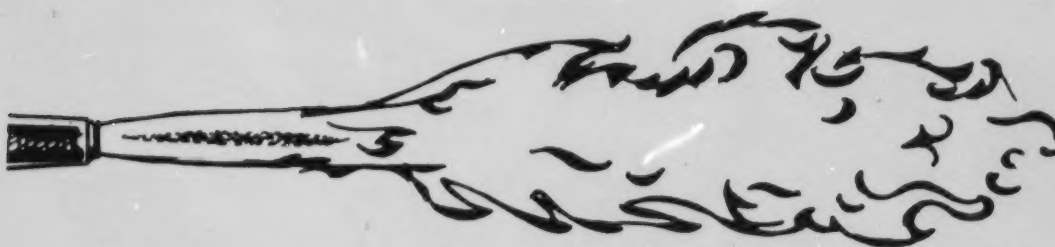
4. Write the correct name of each of the oxyacetylene welding flames in the correct blank.

Neutral

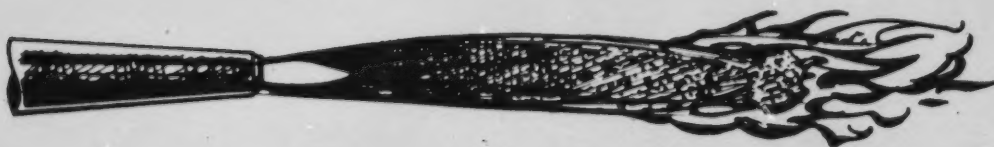
Acetylene burning in air

Oxidizing

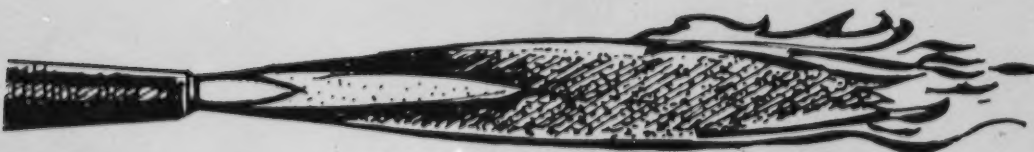
Carburizing



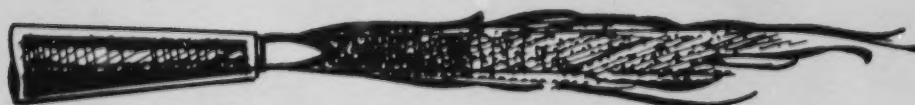
a. _____



b. _____



c. _____



d. _____

5. Demonstrate the ability to:

- a. Set up oxyacetylene equipment for welding.
- b. Turn on, light, and adjust the welding torch, form a weld puddle, and turn off the torch properly.
- c. Produce the types of welding flames used in welding.

(NOTE: If these have not been accomplished prior to test, ask the instructor when the above activities should be completed.)

UNIT I

INTRODUCTION TO OXYACETYLENE WELDING

ANSWERS TO TEST

PART 1

1. Discussion should include:
 - a. Acetylene was first found in a free state.
 - b. Acetylene was not used commercially until it was first produced by mixing calcium carbide with water.
 - c. Acetylene was first produced in low pressure generators.
 - d. Acetylene is stored in cylinders because this is safer than the generator method of production.
2.

a. True	j. False	s. False
b. True	k. False	t. True
c. False	l. True	u. True
d. True	m. True	v. False
e. False	n. True	w. True
f. True	o. False	x. True
g. True	p. True	y. True
h. True	q. False	z. False
i. True	r. True	

PART 2

3.

a. 6	f. 8
b. 7	g. 2
c. 1	h. 9
d. 10	i. 4
e. 3	j. 5

PART 3

4.
 - a. Acetylene burning in air
 - b. Carburizing
 - c. Netural
 - d. Oxidizing
5. Evaluated to the satisfaction of the instructor.

UNIT II

OXYACETYLENE WELDING POSITIONS AND APPLICATIONS

UNIT OBJECTIVE

After completion of this unit, the student will be able to use the correct welding terminology in pointing out the factors involved in producing a good oxyacetylene weld. The student will be able to perform various welds, with and without filler rod and braze weld, using the proper techniques. This knowledge will be evidenced through demonstration and by satisfactorily completing a unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student will be able to:

1. Match oxyacetylene welding terms with the correct definitions.
2. Select the factors that will affect the quality of oxyacetylene weld.
3. Determine which factors should be considered when selecting a filler rod.
4. Identify factors that should be considered when selecting a filler rod.
5. Determine the properties of a good weld.
6. Determine which welds do not require filler rod.
7. Determine which welds require filler rod.
8. Recognize the welding positions used in welding.
9. Select the correct weave patterns used in oxyacetylene welding.
10. Point out the advantages and disadvantages of brazing.
11. List the steps in preparing metal for brazing.
12. Point out the uses of flux.

13. Demonstrate the ability to:
 - a. Lay a weld bead without filler rod.
 - b. Lay a flange weld without filler rod.
 - c. Lay an outside corner weld without filler rod.
 - d. Lay a flat butt weld with proper size filler rod.
 - e. Lay a lap weld with filler rod.
 - f. Lay an inside corner weld with filler rod.
 - g. Braze a butt joint.

UNIT II

OXYACETYLENE WELDING POSITIONS AND APPLICATIONS

SUGGESTED ACTIVITIES

I. Instructor

- A. Provide students with objective sheet.
- B. Provide students with information and job sheets.
- C. Discuss unit and specific objectives.
- D. Discuss information sheet.
- E. Demonstrate and discuss procedures outlined in job sheets.
- F. Give test.

II. Student

- A. Read objectives.
- B. Study information sheet.
- C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objective sheet
- B. Information sheets
 - 1. Information Sheet #1--Terminology
 - 2. Information Sheet #2--The Oxyacetylene Weld
 - 3. Information Sheet #3--Position Welding
 - 4. Information Sheet #4--Brazing

C. Transparency masters

1. TM-1--Flat Butt Weld (No Filler Rod)
2. TM-2--Flat Flange Weld (No Filler Rod)
3. TM-3--Flat Corner Weld (No Filler Rod)
4. TM-4--Flat Butt Weld
5. TM-5--Flat Lap Weld
6. TM-6--Flat Tee Weld
7. TM-7--Braze Welding

D. Job Sheets

1. Job Sheet #1--Lay a Weld Bead Without Filler Rod
2. Job Sheet #2--Lay a Flange Weld Without Filler Rod
3. Job Sheet #3--Lay an Outside Corner Weld Without Filler Rod
4. Job Sheet #4--Lay a Flat Butt Weld with Proper Size Filler Rod
5. Job Sheet #5--Lay a Lap Weld with Filler Rod
6. Job Sheet #6--Lay an Inside Corner Weld with Filler Rod
7. Job Sheet #7--Braze a Butt Joint

E. Test

F. Answers to Test

G. References:

1. Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. Modern Welding. South Holland, Illinois: The Goodheart-Wilcox Co., Inc., 1970
2. Little, Richard L. Welding and Welding Technology. New York, N.Y.: McGraw-Hill Book Company, 1973
3. Pender, James A. Welding. Toronto, New York: McGraw-Hill Book Company, 1968

UNIT II

OXYACETYLENE WELDING POSITIONS AND APPLICATIONS

INFORMATION SHEET #1--TERMINOLOGY

I. Terms and Definitions

- A. Fusion welding--Joining two pieces of metal by heating the adjoining edges to the melting point, allowing them to flow together, and then cool.
- B. Penetration--The depth the heat of the torch melts the metal during welding.
- C. Puddling--Heating the base metal to its melting point and moving the pool of molten metal steadily down the length of the base metal.
- D. Base metal--The metal to be welded.
- E. Weave--The circular movement of the torch causing uniform patterns on the metal.
- F. Inner cone--The white part inside the neutral flame.
- G. Filler rod--The extra metal added to a weld to create the correct weld shape and strength.
- H. Buildup--The metal on top of the weld area.
- I. Forehand welding--Moving the torch down the metal, with the tip pointing in the direction to be welded.
- J. Backhand welding--Use of the torch during welding so that the flame is directed back over the area that has been welded.
- K. Tack weld--Placing a small weld on a piece of base metal to hold the metal into place.
- L. Backfire--A sudden burning-back of the flame into the tip and the flame then goes out with a loud "pop."
- M. Flashback--A fire burning inside the torch, causing a squealing or hissing sound.
- N. Brazing--Joining two pieces of metal, using a brass rod and flux.
- O. Flux--A chemical used to clean metals during the welding process.

UNIT II

OXYACETYLENE WELDING POSITIONS AND APPLICATIONS

INFORMATION SHEET #2--THE OXYACETYLENE WELD

- II. Factors which affect the quality of an oxyacetylene weld.
 - A. Proper torch adjustment
 - B. Angle of tip
 - C. Distance of tip from base metal
 - D. Movement of tip
 - E. Rate of travel
- III. Factors determining tip size selection
 - A. Thickness of metal
 - B. Size of welding rod
- IV. Factors determining rod selection
 - A. Rod with similar properties as base metal
 - B. Size of weld fillet
- V. Properties of a good weld
 - A. Is fused into base metal
 - B. Has same width entire length of the bead
 - C. Has a slightly rounded buildup
 - D. Is straight or follows proper path
 - E. Has a clean appearance and is free of splatter

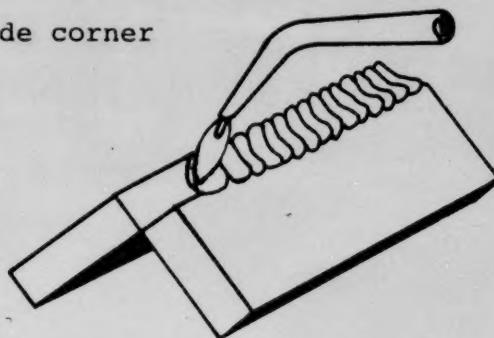
UNIT II

OXYACETYLENE WELDING POSITIONS AND APPLICATIONS

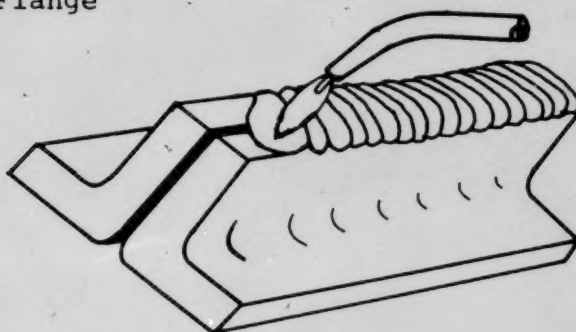
INFORMATION SHEET #3--POSITION WELDING

VI. Types of welds that need no filler rod

A. Outside corner

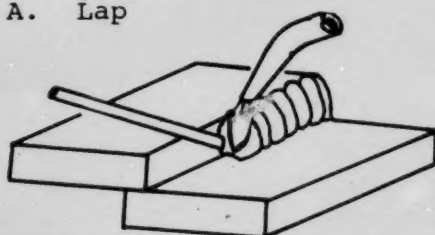


B. Flange

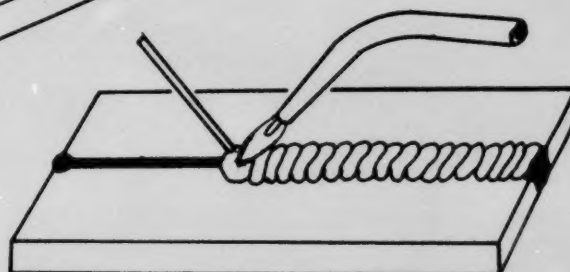


VII. Types of welds that require filler rod

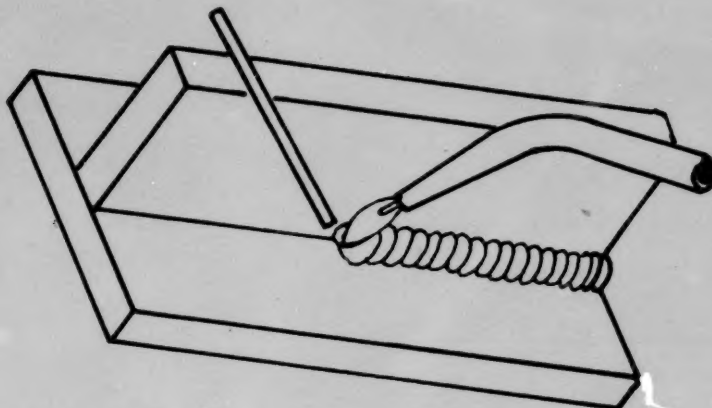
A. Lap



B. Butt

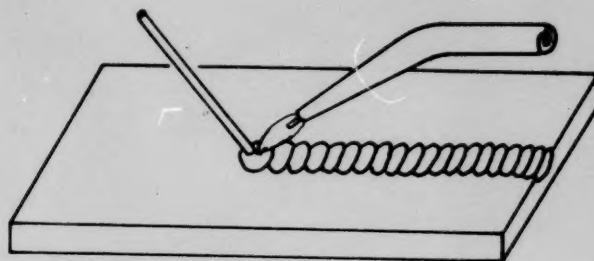


C. Inside corner

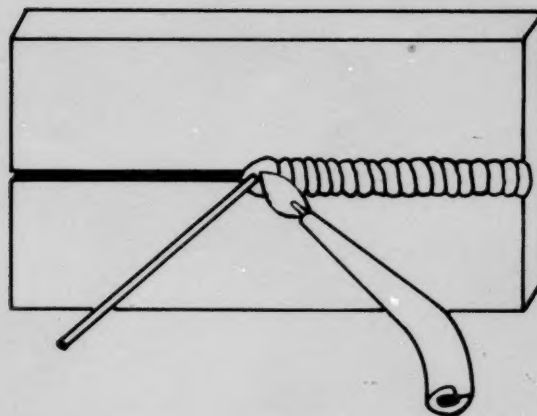


VIII. Weld positions

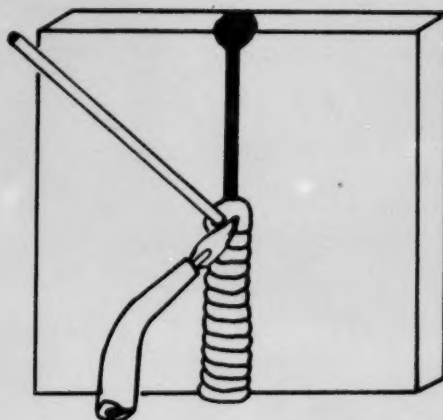
A. Flat



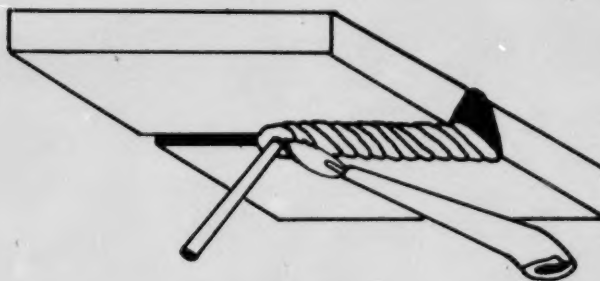
B. Horizontal



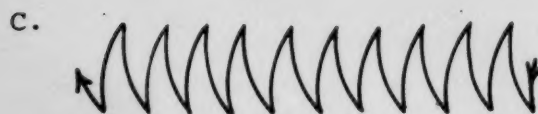
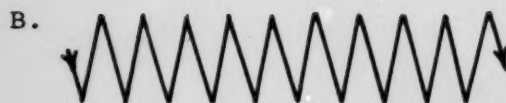
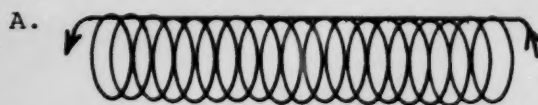
C. Vertical



D. Overhead



IX. Oxyacetylene welding patterns for puddling



UNIT II

OXYACETYLENE WELDING POSITIONS AND APPLICATIONS

INFORMATION SHEET #4--BRAZING

X. Brazing

A. Advantages

1. Uses lower temperature in welding process
2. Can join unlike metals
3. Will weld metals that cannot easily be welded by other processes.

(Example: Cast iron)

4. Does not melt base metal
5. Can be used on light gauge metals

B. Disadvantages

1. Weld is not as strong
2. Brazing materials are expensive

XI. Preparation of Metal Required for Brazing

- A. Clean metal surface to allow free flow of brass.
- B. Prepare castings that will be welded by V-ing out the crack or weld area.

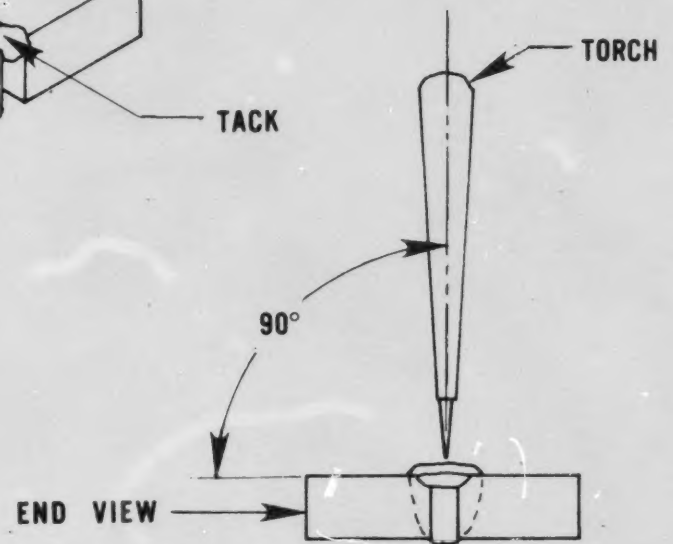
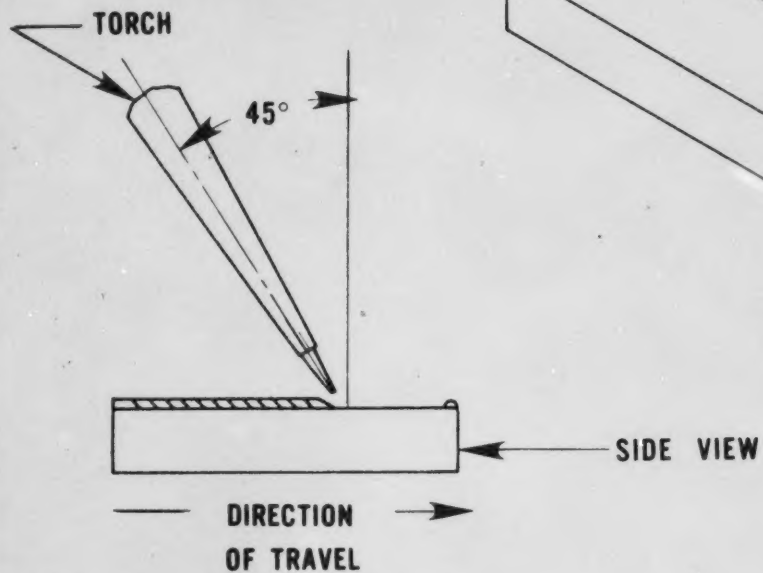
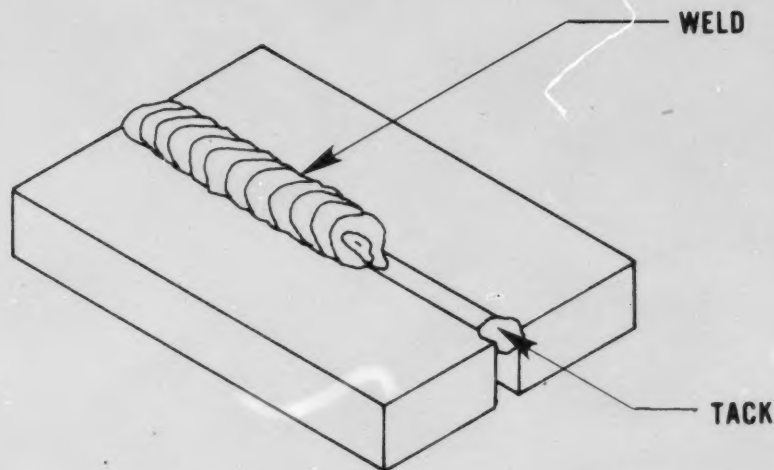
(Example: Crack in car exhaust manifold)

- C. Preheat metal slightly.

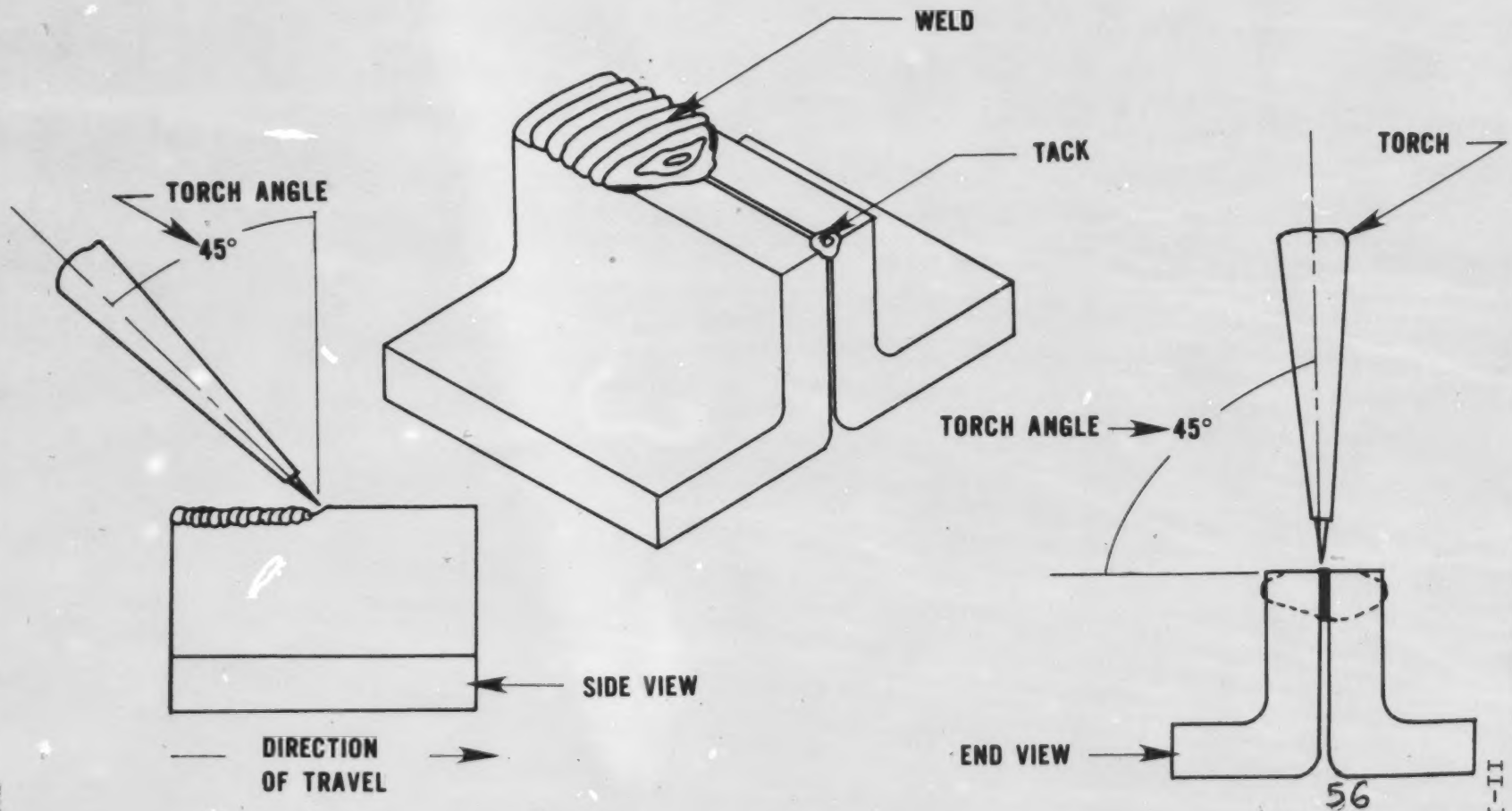
XII. Purpose of Flux

- A. Helps clean the base metal
- B. Eases flow of brass filler rod
- C. Allows brass filler rod to enter base metal pores
- D. Prevents oxidation of filler rod and base metal

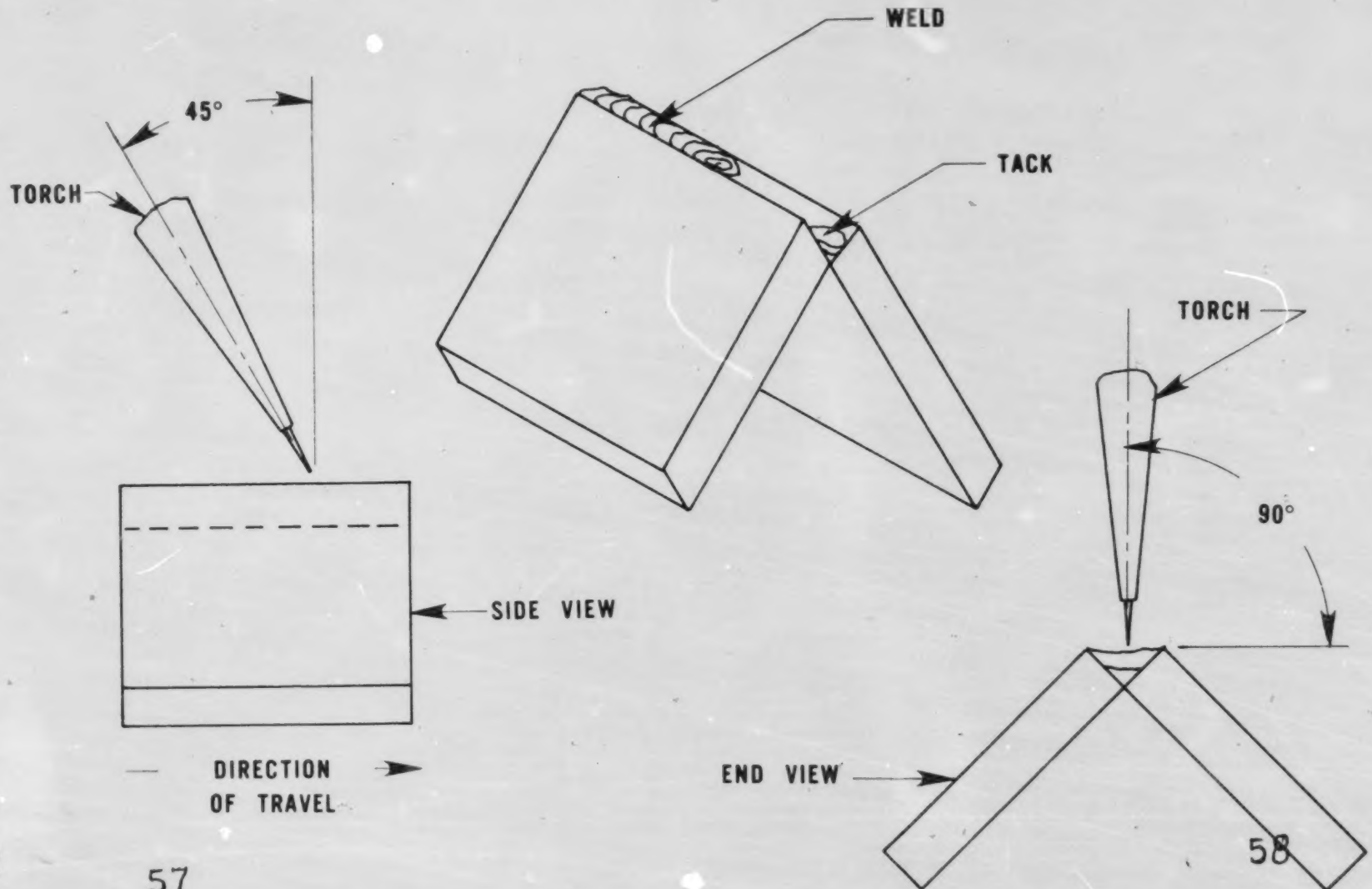
FLAT BUTT WELD (NO FILLER ROD)



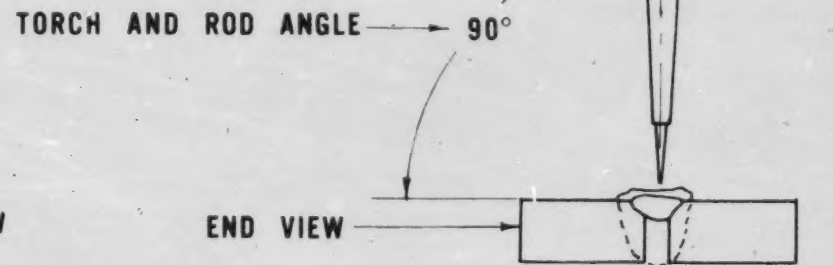
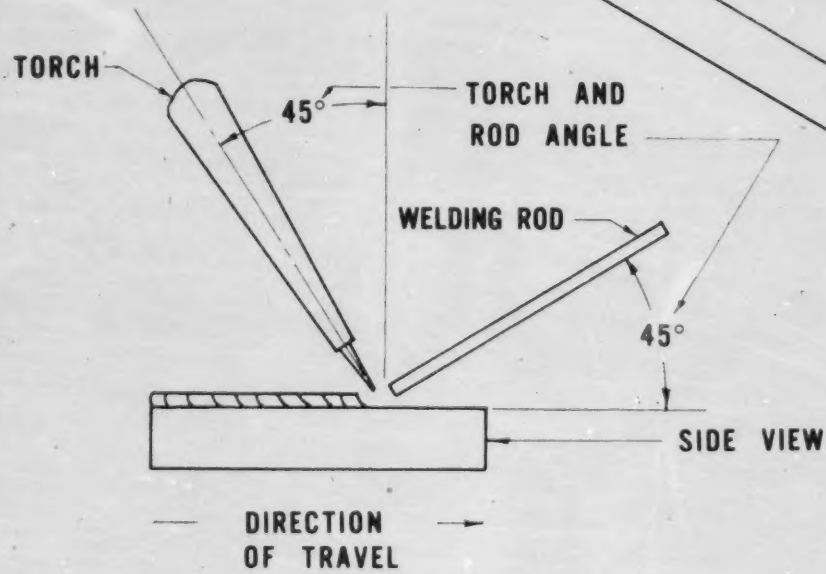
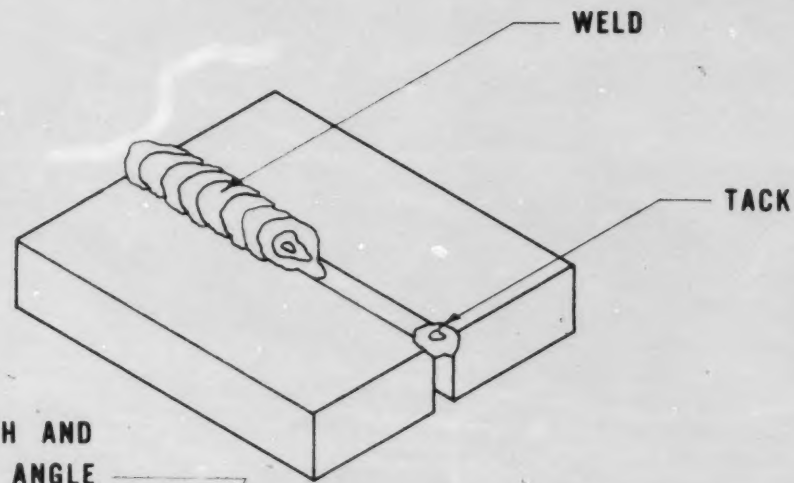
FLAT FLANGE WELD (NO FILLER ROD)



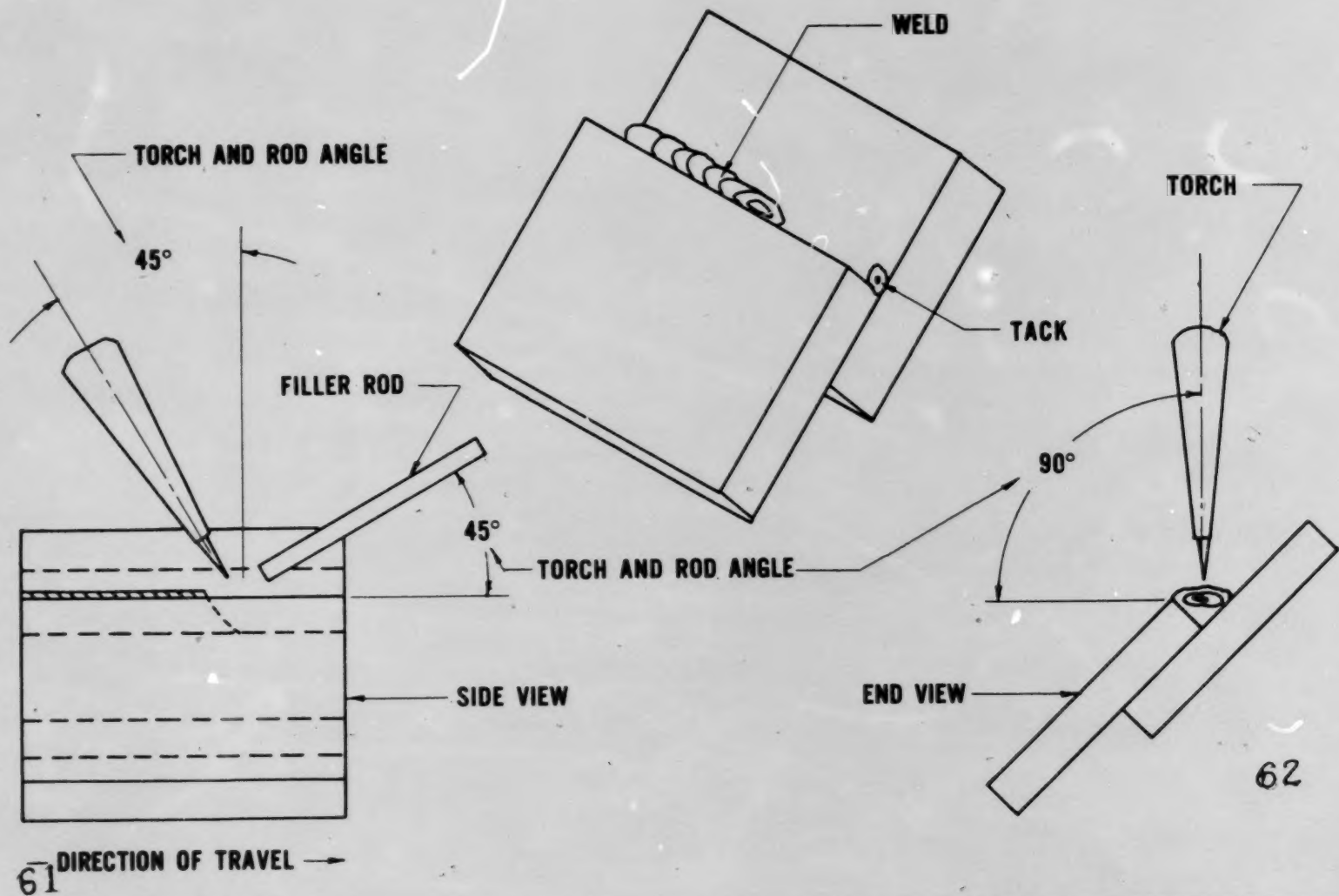
FLAT CORNER WELD (NO FILLER ROD)



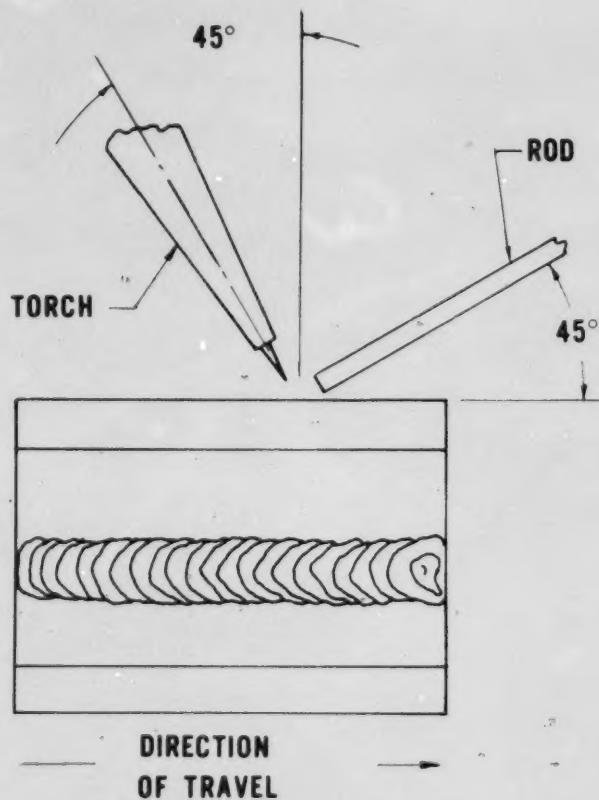
FLAT BUTT WELD



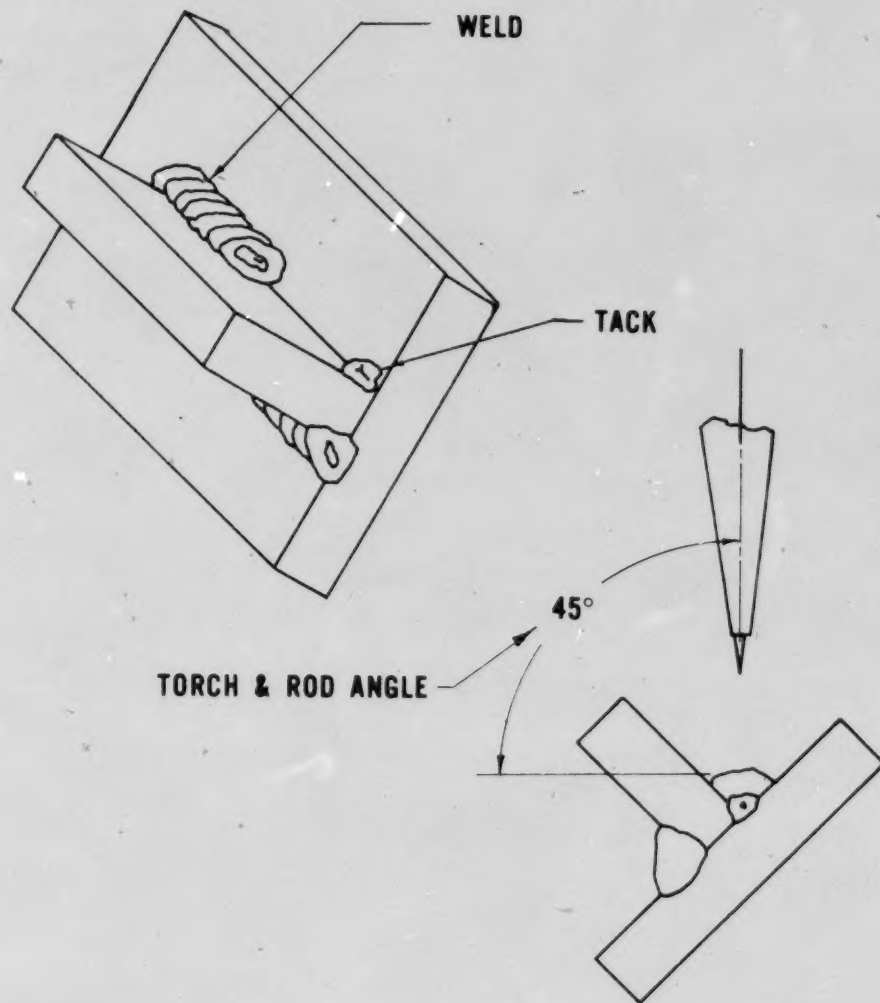
FLAT LAP WELD



FLAT TEE WELD

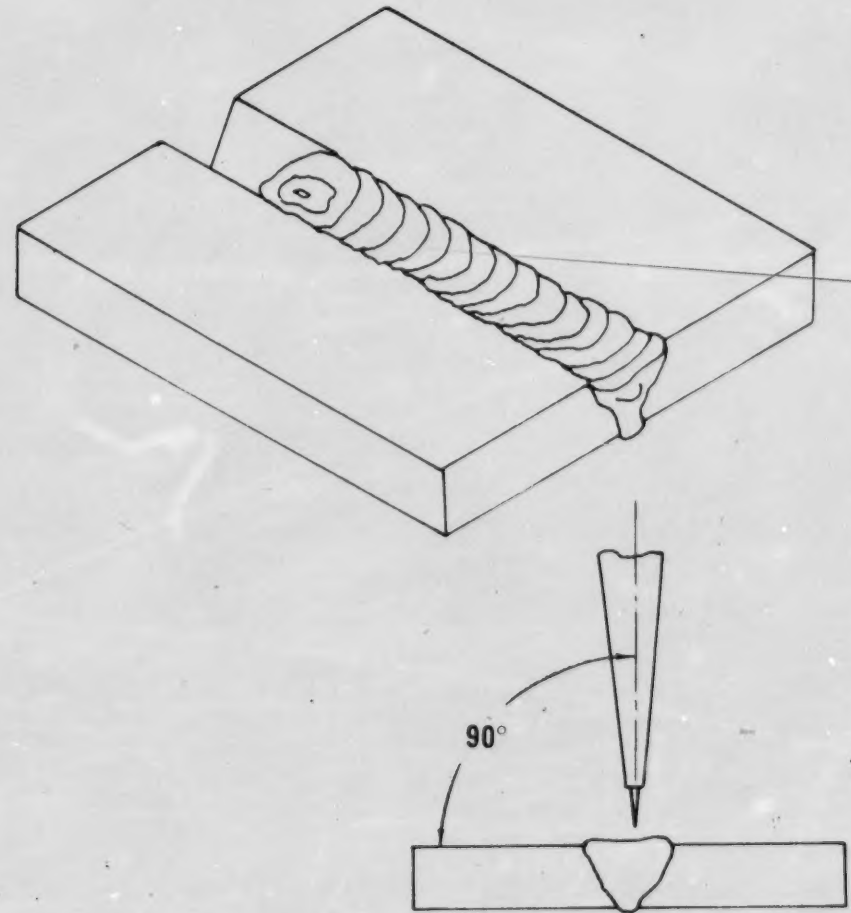
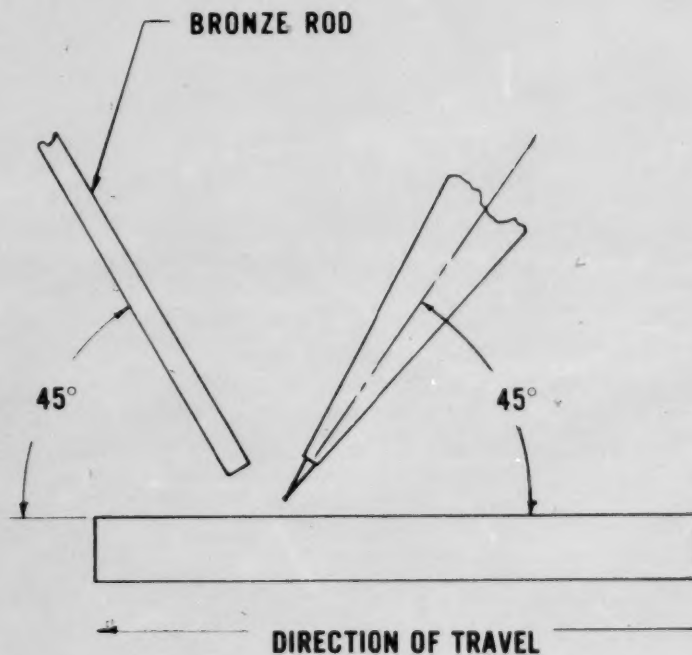


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BRAZE WELDING

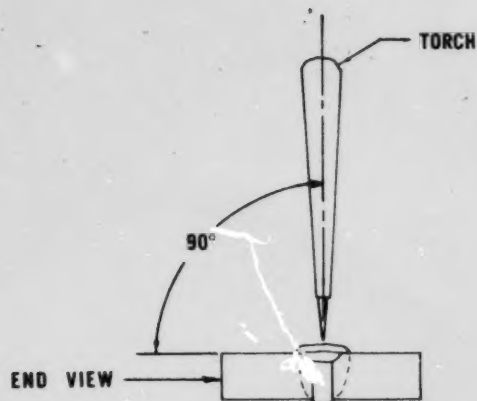


UNIT II

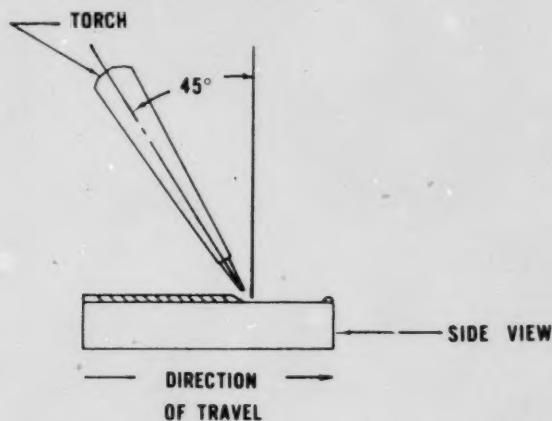
OXYACETYLENE WELDING POSITIONS AND APPLICATIONS

JOB SHEET #1--LAY A WELD BEAD WITHOUT FILLER ROD

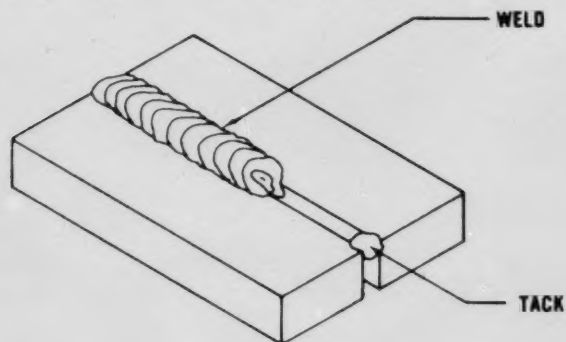
- I. Tools, equipment, and materials required
 - A. Oxyacetylene welding unit
 - B. Fire brick table
 - C. Gloves
 - D. Goggles
 - E. Pliers
 - F. Cooling vat
 - G. Wire brush
 - H. No. 1 welding tip
 - I. Flint lighter
 - J. Coveralls
 - K. One piece of 16-gauge metal (approximately 4 x 6 inches)
- II. Procedure
 - A. Put on oxyacetylene goggles, gloves, and coveralls
 - B. Prepare metal
 - C. Turn on oxyacetylene welding unit (5 PSI acetylene, 20 PSI oxygen)
 - D. Light the torch and adjust to a neutral flame
 - E. Place inner cone about 1/8 to 1/4 inch away from the direction of the weld



- F. Hold torch at about 30° to 45° away from the direction of the weld.



- G. As a puddle forms, move the torch along slowly, using one of the weave patterns.



- H. Repeat this beading process until a good weld bead becomes easy to produce.

- I. If popping occurs:

1. Clean metal
2. Raise tip slightly

3. Clean tip
4. Tighten nut holding tip on torch
5. Replace O-rings on tip
6. Adjust torch flame

J. If a melt-through occurs:

1. Adjust heat of torch to a smaller inner core
2. Place metal on a back up plate and clamp to it
3. Clean rust or dirt from metal

UNIT II

OXYACETYLENE WELDING POSITIONS AND APPLICATIONS

JOB SHEET #2--LAY A FLANGE WELD WITHOUT FILLER ROD

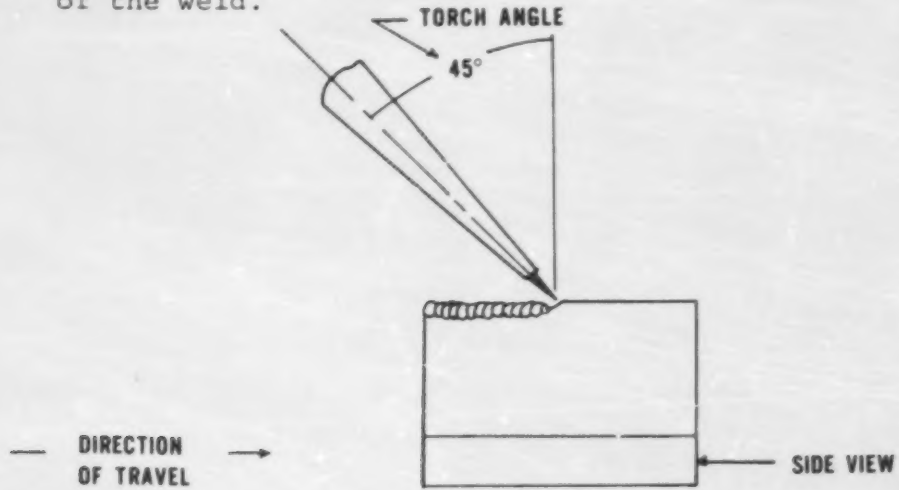
I. Tools, equipment, and materials required:

- A. Oxyacetylene welding unit
- B. Fire brick table
- C. Gloves
- D. Goggles
- E. Pliers
- F. Cooling vat
- G. Wire brush
- H. No. 1 welding tip
- I. Flint lighter (striker)
- J. Coveralls
- K. Two pieces of 16-gauge metal (approximately 2 x 3 inches)
- L. Bend each into an L-shape down the 3-inch length with the flange being the same length on each.

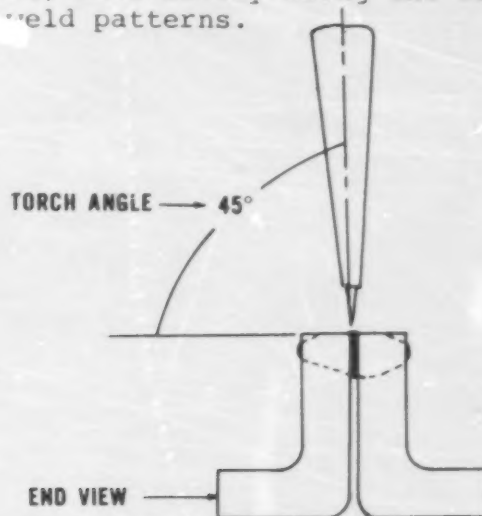
II. Procedure

- A. Put on coveralls, oxyacetylene goggles, and gloves
- B. Prepare metal
- C. Place metal on table with flanges pointed up and together
- D. Turn on oxyacetylene welding unit (5 PSI acetylene, 20 PSI oxygen)
- E. Light and adjust torch to a neutral flame
- F. Tack each end of flanges by placing flame about 1/8 inch from each corner of the flanges until they melt together

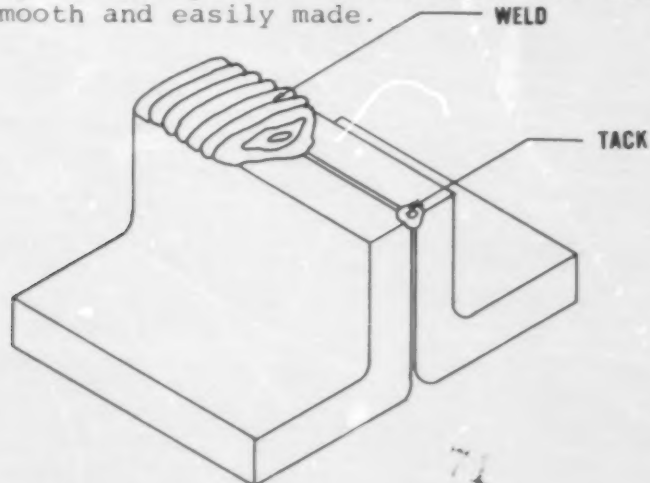
- G. Hold torch at about 45° away from the direction of the weld.



- H. As the flange melts, move slowly along the flange using one of the weld patterns.



- I. Repeat this process until the welds become smooth and easily made.



UNIT II

OXYACETYLENE WELDING POSITIONS AND APPLICATIONS

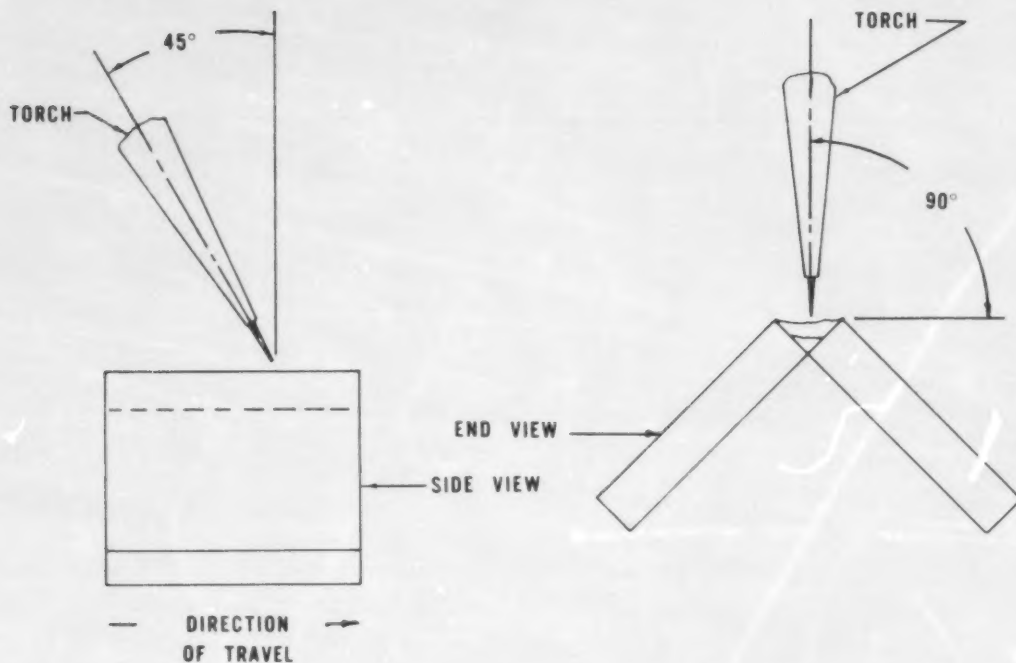
JOB SHEET #3--LAY AN OUTSIDE CORNER WELD WITHOUT FILLER ROD

I. Tools, equipment, and materials required

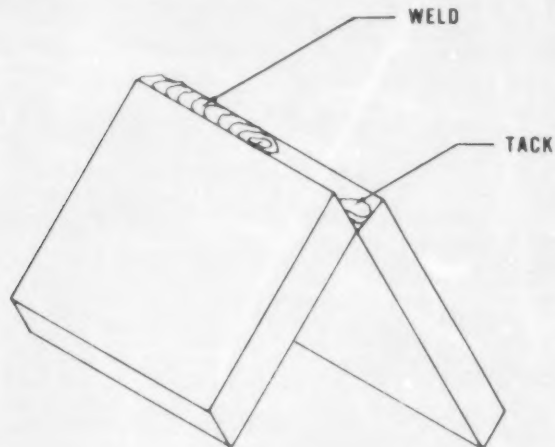
- A. Oxyacetylene welding unit
- B. Fire brick table
- C. Gloves
- D. Goggles
- E. Pliers
- F. Cooling vat
- G. Wire brush
- H. No. 1 welding tip
- I. Flint lighter
- J. Coveralls
- K. Two pieces of 16-gauge mild steel plate (approximately 2 x 3 inches)

II. Procedure

- A. Put on coveralls, oxyacetylene glasses, and gloves
- B. Select metal
- C. Place metal on table in an upside down V position
- D. Turn on acetylene unit (5 PSI acetylene 20 PSI oxygen)
- E. Light and adjust torch to a neutral flame
- F. Tack the metal in place at each end
- G. Place inner cone $1/8$ to $1/4$ inch from corner
- H. Hold torch at 30° to 45° away from the direction of the weld



- I. As the corner of each piece melts together, move slowly along the entire length of the material



- J. Repeat this process until the weld is smooth and easily made.

UNIT II

OXYACETYLENE WELDING POSITIONS AND APPLICATIONS

JOB SHEET #4--LAY A FLAT BUTT WELD WITH PROPER SIZE FILLER ROD

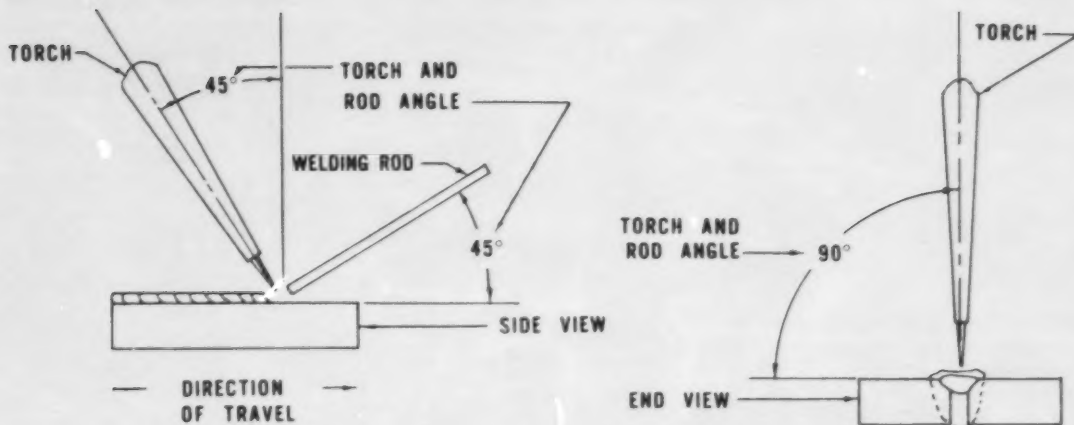
I. Tools, equipment, and materials required

- A. Oxyacetylene welding unit
- B. Fire brick table
- C. Gloves
- D. Goggles
- E. Pliers
- F. Cooling vat
- G. Flint lighter
- H. Wire brush
- I. No. 1 welding tip
- J. Coveralls
- K. One piece of 16-gauge mild steel plate (approximately 4 x 6 inches)
- L. 1/16 inch filler rod (clothes hangers work as well)

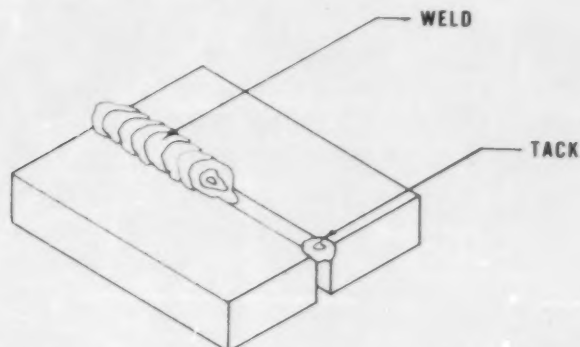
II. Procedure

- A. Put on oxyacetylene glasses, coveralls, and gloves
- B. Prepare metal
- C. Turn on oxyacetylene welding unit (5 PSI acetylene, 20 PSI oxygen)
- D. Light and adjust torch to a neutral flame
- E. Place inner cone about 1/8 to 1/4 inch away from the plate

- F. Hold torch at about 30° to 45° away from the direction of the weld



- G. As the puddle forms, add filler rod to the front edge of the puddle until you get the proper buildup
- H. Move the puddle along with the torch using one of the weave patterns



- I. Add and withdraw the filler rod as you need more buildup metal deposited
- J. Keep the same amount of buildup the entire length of the weld
- K. Repeat the process until you can easily make a good weld

UNIT II

OXYACETYLENE WELDING POSITIONS AND APPLICATIONS

JOB SHEET #5--LAY A LAP WELD WITH FILLER ROD

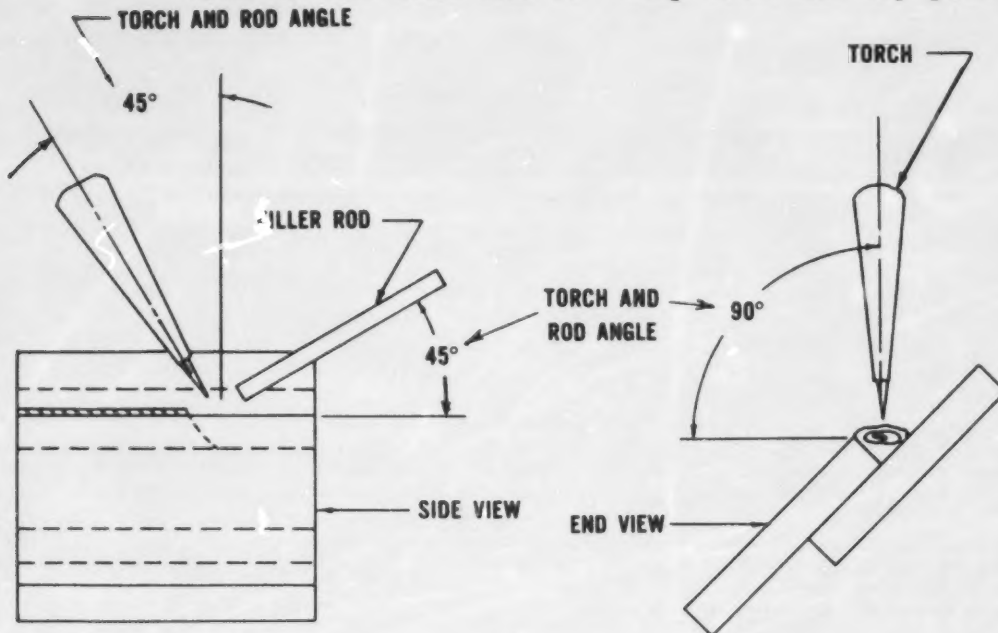
I. Tools, equipment, and materials required

- A. Oxyacetylene welding unit
- B. Fire brick table
- C. Gloves
- D. Goggles
- E. Pliers
- F. Cooling vat
- G. Wire brush
- H. No. 1 welding tip
- I. Flint lighter
- J. Coveralls
- K. Two pieces 16-gauge, 2 x 3 inch metal
- L. 1/16 inch filler rod (clothes hangers work as well)

II. Procedure

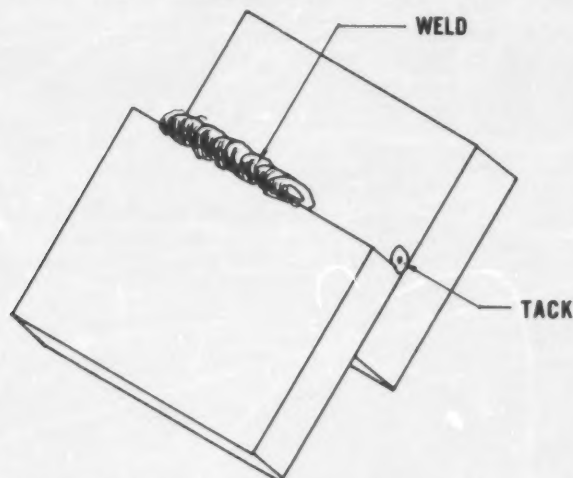
- A. Put on oxyacetylene glasses, coveralls, and gloves
- B. Prepare metal and place on the table with the 3-inch sides overlapping
- C. Turn on oxyacetylene welding unit (5 PSI acetylene, 20 PSI oxygen)
- D. Light and adjust torch to a neutral flame
- E. Tack weld the two plates in place by melting the corners of the top plate to the bottom plate
- F. Place inner cone 1/8 to 1/4 inch away from the bottom plate allowing the cone to slightly miss the top plate

- G. Hold the torch at about 45° away from the direction of the weld and 45° away from the top plate



— DIRECTION OF TRAVEL —

- H. As the plates melt and form a puddle, add filler rod until you get the proper build up
- I. Move the puddle along with the torch using one of the weave patterns



- J. Add and withdraw the filler rod as you need buildup on the weld area

- K. Keep the buildup the same over the entire weld length and bonded equally to the top and bottom plates
- L. Repeat the process until the weld can be easily made and has the proper appearance

UNIT II

OXYACETYLENE WELDING POSITIONS AND APPLICATIONS

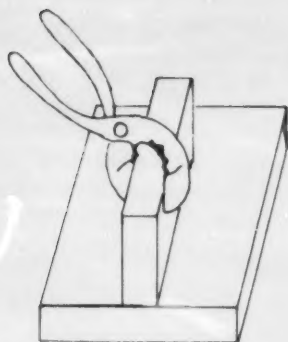
JOB SHEET #6--LAY AN INSIDE CORNER WELD WITH FILLER ROD

I. Tools, equipment, and materials required

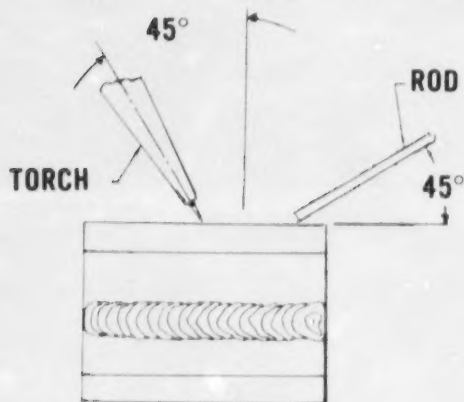
- A. Oxyacetylene welding unit
- B. Fire brick table
- C. Gloves
- D. Goggles
- E. Pliers
- F. Cooling vat
- G. Wire brush
- H. No. 1 welding tip
- I. Flint lighter
- J. Coveralls
- K. Two pieces 16-gauge metal (approximately 2 x 3 inches)
- L. 1/16 inch filler rod (clothes hangers work as well)

II. Procedure

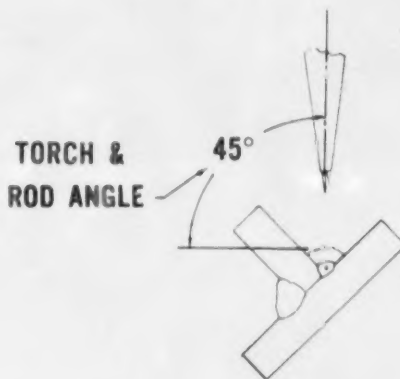
- A. Put on coveralls, oxyacetylene goggles, and gloves
- B. Prepare metal
- C. Turn on the oxyacetylene welding unit (5 PSI acetylene, 20 PSI oxygen)
- D. Light and adjust torch to a neutral flame
- E. Holding one plate on the 2-inch side with pliers, place it in the middle of the other plate with the ends lined up



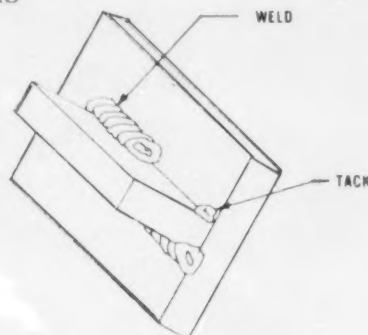
- F. Tack the plate in place by heating the corners of the top plate where they meet the bottom plate until they melt together
- G. Place inner cone 1/8 to 1/4 inch away from the corner formed by the two plates
- H. Hold the torch at about 45° away from the direction of the weld and 45° away from the top plate



DIRECTION OF TRAVEL →



- I. As the plates melt and form a puddle, add filler rod until you get the proper buildup
- J. Move the puddle along with the torch using one of the weave patterns



- K. Add and withdraw filler rod as buildup is needed on the weld area
- L. Keep the buildup the same over the entire weld length and bonding equally with the top and bottom plates
- M. Repeat the process until the weld can easily be made and has the proper appearance

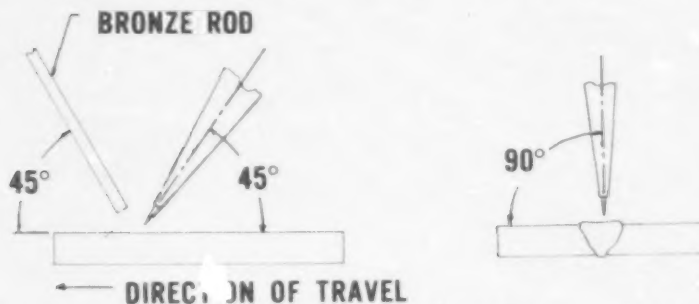
UNIT II

OXYACETYLENE WELDING POSITIONS AND APPLICATIONS

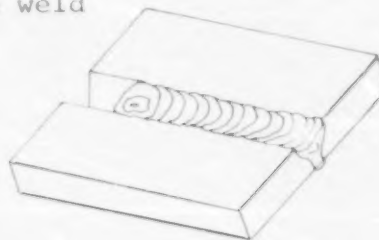
JOB SHEET #7--BRAZE A BUTT JOINT

- I. Tools, equipment, and materials required
 - A. Oxyacetylene welding unit
 - B. Fire brick table
 - C. Gloves
 - D. Goggles
 - E. Pliers
 - F. Cooling vat
 - G. Wire brush
 - H. No. 1 welding tip
 - I. Flint lighter
 - J. Coveralls
 - K. Two pieces of 16-gauge metal (approximately 2 x 3 inches)
 - L. 1/16 inch bronze filler rod
 - M. Welding flux
- II. Procedure
 - A. Put on coveralls, oxyacetylene goggles, and gloves
 - B. Prepare metal and place on table leaving 1/16 inch gap down the three-inch lengths
 - C. Turn on oxyacetylene welding unit (5 PSI acetylene, 20 PSI oxygen)
 - D. Light and adjust torch to a neutral flame
 - E. Preheat the brazing rod end approximately 1 inch in length and dip in flux
 - F. Tack weld plate in place at each end of the gap

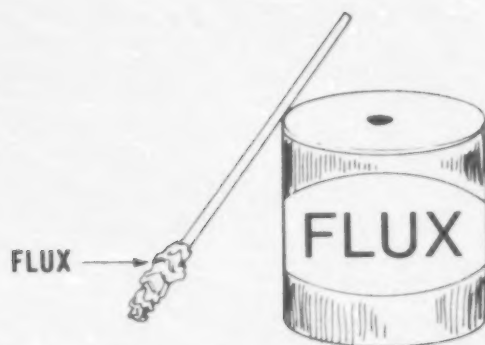
- G. Place the inner cone about 1/8 to 1/4 inch away from the weld plate gap
- H. Hold the torch about 45° off of the plate and leaning away from the direction of travel



- I. Heat the plates at the starting point of the weld until the metal begins to get red
(CAUTION: Do not overheat the metal)
- J. Begin depositing filler rod as you move a puddle of brass along the weld



- K. Reduce the rate of travel if the brass forms drops
- L. Lower the torch temperature if the brass tends to boil away
(NOTE: Watch the base metal color)
- M. Add and withdraw filler rod to produce a slight buildup
- N. Keep the amount of buildup the same over the entire length of the weld
- O. Dip the rod into the flux when it is melted away



- P. Repeat this welding technique until it becomes easily done and becomes uniform in appearance

UNIT II

OXYACETYLENE WELDING POSITIONS AND APPLICATIONS

TEST--PART I

1. Match each of the following terms with the correct definitions. Write the number of the correct term in the blank provided.

- | | |
|--|---------------------|
| _____ a. The joining of two pieces of metal by heating the adjoining edges to the melting point and allowing them to flow together and then cool | 1. Flux |
| _____ b. The heating of the base metal to its melting point and moving a pool of metal steadily down the length of the base metal | 2. Flashback |
| _____ c. The circular movement of the torch causing uniform patterns on the metal | 3. Brazing |
| _____ d. The extra metal added to a weld to create the correct weld shape and strength | 4. Backfire |
| _____ e. The type of welding in which you are moving the torch down the metal with the tip pointing in the direction to be welded | 5. Tack weld |
| _____ f. Placing a small weld on a piece of metal to hold it in place | 6. Backhand welding |
| _____ g. A fire burning inside the torch causing a squealing or hissing sound | 7. Forehand welding |
| | 8. Buildup |
| | 9. Filler rod |
| | 10. Inner cone |
| | 11. Weave |
| | 12. Base metal |
| | 13. Puddling |
| | 14. Penetration |
| | 15. Fusion welding |

- | | |
|---|---------------------|
| _____ h. A chemical used to clean metal during the welding process | 1. Flux |
| _____ i. The depth to which the heat of the torch melts the metal during welding | 2. Flashback |
| _____ j. The metal to be welded | 3. Brazing |
| _____ k. The white part inside a neutral flame | 4. Backfire |
| _____ l. The metal on top of the weld area | 5. Tack weld |
| _____ m. The type of welding in which the flame is directed back over the area that has been welded | 6. Backhand welding |
| _____ n. A sudden burning back of the flame into the tip as the flame goes out with a pop | 7. Forehand welding |
| _____ o. Joining two pieces of metal to form one, using a brass rod and flux | 8. Buildup |
| | 9. Filler rod |
| | 10. Inner cone |
| | 11. Weave |
| | 12. Base metal |
| | 13. Puddling |
| | 14. Penetration |
| | 15. Fusion welding |

UNIT II

OXYACETYLENE WELDING POSITIONS AND APPLICATIONS

TEST--PART 2

2. Select the five factors that affect the quality of an oxyacetylene weld by circling the letter in front of each.
- a. Proper torch adjustment
 - b. Brand of torch used
 - c. Angle of tip
 - d. Length of weld metal
 - e. Distance of tip from base metal
 - f. Movement of tip
 - g. Rate of travel
3. Place a "✓" in front of each of the following factors that should be considered when selecting a tip size for welding.
- _____ a. Thickness of metal
 - _____ b. Position of weld
 - _____ c. Size of welding rod
- 
4. Choose two of the following factors that should be considered when selecting a filler rod by placing a "✓" in front of each.
- _____ a. Size of weld torch
 - _____ b. Rod with similar properties of base metal
 - _____ c. Size of weld fillet

5. Determine whether each of the statements is or is not one of the properties of a good weld by answering yes or no:

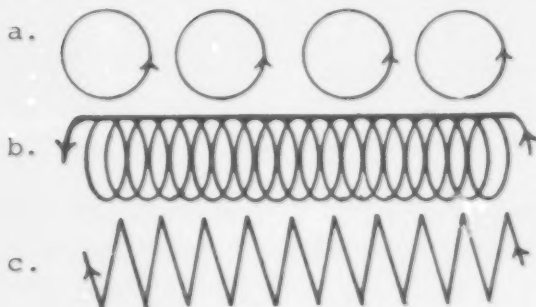
- ☐ a. Fuses with the base metal
- ☐ b. Plenty of weld splatter
- ☐ c. Top of weld sinks in
- ☐ d. Weld is same width its entire length
- ☐ e. Weld is straight

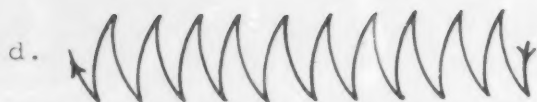
UNIT II

OXYACETYLENE WELDING POSITIONS AND APPLICATIONS

TEST--PART 3

6. Determine which welds do not require filler rod
(Circle the correct answer)
- a. Outside corner weld or inside corner weld
 - b. Flange weld or V-butt weld
7. Determine which welds require filler rod
(Circle the correct answer)
- a. Lap weld or flange weld
 - b. Outside corner or butt weld
 - c. Inside corner weld or flange weld
8. List the four welding positions used in welding
- a.
 - b.
 - c.
 - d.
9. Select the correct weave patterns used in oxyacetylene welding. (Underline the correct patterns)





UNIT II

OXYACETYLENE WELDING POSITIONS AND APPLICATIONS

TEST--PART 4

10. Point out the advantages and disadvantages of brazing by using the abbreviations dis or ad for each of the following statements:
- ☐ a. Brazing does not have the strength of an arc weld.
 - ☐ b. Brazing uses less temperature in the welding process.
 - ☐ c. Brazing materials are expensive.
 - ☐ d. Brazing does not melt base metal.
 - ☐ e. Brazing can join unlike metals.
 - ☐ f. Brazing can be done on light metal.
 - ☐ g. Brazing will bond cast iron.
11. List the steps in preparing metal for brazing.
- a.
 - b.
 - c.
12. Point out the uses of flux. Circle the letter in front of each correct use.
- a. Helps clean the base metal
 - b. Cleans the air of fumes
 - c. Eases flow of brass filler rod
 - d. Allows brass filler rod to enter base metal pores
 - e. Prevents oxidation of filler rod and base metal
 - f. Allows base metal to melt more quickly

13. Demonstrate the ability to:

- a. Lay a weld bead without filler rod
- b. Lay a flange weld without filler rod
- c. Lay an outside corner weld without filler rod
- d. Lay a flat butt weld with proper size filler rod
- e. Lay a lap weld with filler rod
- f. Lay an inside corner weld with filler rod
- g. Braze a butt joint

(NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

UNIT II

OXYACETYLENE WELDING POSITIONS AND APPLICATIONS

ANSWERS TO TEST - PART 1

- | | | |
|-----------------|--------------|--------------|
| 1. <u>15</u> a. | <u>5</u> f. | <u>10</u> k. |
| <u>13</u> b. | <u>2</u> g. | <u>8</u> l. |
| <u>11</u> c. | <u>1</u> h. | <u>6</u> m. |
| <u>9</u> d. | <u>14</u> i. | <u>4</u> n. |
| <u>7</u> e. | <u>12</u> j. | <u>3</u> o. |

PART 2

2. a
c
e
f
g
3. ✓ a.
 b.
✓ c.
4. a.
✓ b.
✓ c.
5. yes a. yes e.
no b.
no c.
yes d.

PART 3

6. a. Outside corner weld
b. Flange weld
7. a. Lap weld
b. Butt weld
c. Inside corner
8. a. Overhead
b. Horizontal
c. Vertical
d. Flat
9. The correct patterns are:
b.
c.
d.

PART 4

10. dis a. ad e.
 ad b. ad f.
 dis c. ad g.
 ad d.
11. a. Clean metal surface
b. V-out weld area
c. Preheat metal slightly
12. a c d e
13. Evaluated to the satisfaction of the instructor.

UNIT III

USE OF THE CUTTING TORCH

UNIT OBJECTIVE

After completion of this unit, the student will be able to use the correct terminology in pointing out the parts of the cutting torch equipment and factors involved during cutting torch operations. The student will be able to lay out material to be cut and safely perform various operations using the cutting torch.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match the terms associated with oxyacetylene cutting to the correct definition.
2. Identify the parts of the torch body and cutting attachment.
3. Point out the hazards of hot slag.
4. Determine the causes of a backfire.
5. Describe the results of a backfire.
6. Describe the results of a flashback.
7. Determine the reasons for a poor cut with the cutting torch.
8. Demonstrate the ability to:
 - a. Turn on, light, adjust, and turn off the oxyacetylene cutting torch.
 - b. Lay out lines on a piece of metal and cut with cutting torch at a 90° angle.
 - c. Make a 45° beveled cut.
 - d. Cut a hole in steel plate.

UNIT III
USE OF THE CUTTING TORCH

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students with information and job sheets.
- C. Make transparencies.
- D. Discuss unit and specific objectives.
- E. Discuss information sheet.
- F. Demonstrate and discuss procedures outlined in the job sheets.
- G. Give test.

II. Student:

- A. Read objective.
- B. Study information sheet.
- C. Demonstrate ability to accomplish the procedures outlined in the job sheets.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objective
- B. Information sheets
 - 1. Information Sheet #1--Cutting Torch Terminology
 - 2. Information Sheet #2--The Cutting Torch
 - 3. Information Sheet #3--The Cutting Process

C. Transparencies

1. TM-1--Cutting Torch Equipment
2. TM-2--Torches
3. TM-3--Positioning the Torch
4. TM-4--Torch Tips
5. TM-5--Steps in Cutting
6. TM-6--Cutting a Bevel
7. TM-7--Piercing a Hole
8. TM-8--Examples of Poor Torch Cuts

D. Job Sheets

1. Job Sheet #1--Turn On, Light, Adjust, and Turn Off Oxyacetylene Cutting Torch
2. Job Sheet #2--Lay Out Lines on a Piece of Metal and Cut with Cutting Torch at 90° Angle
3. Job Sheet #4--Cut a Hole in Steel Plate

E. Test

F. Answers to Test

II. References

- A. Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. Modern Welding. South Holland, Illinois: The Goodheart-Wilcox Co., Inc. 1970.
- B. Little, Richard L. Welding and Welding Technology. New York, N.Y.: McGraw-Hill Book Company, 1973.
- C. Pender, James A. Welding. Toronto, New York: McGraw-Hill Book Company, 1968.

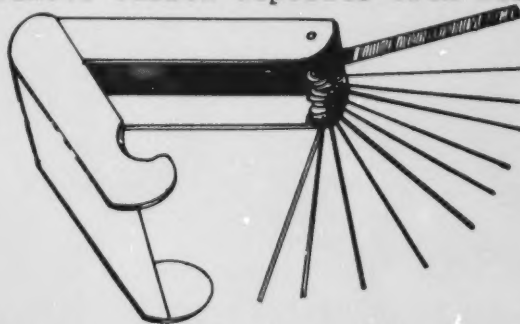
UNIT III

USE OF THE CUTTING TORCH

INFORMATION SHEET #1--CUTTING TORCH TERMINOLOGY

I. Terms and definitions

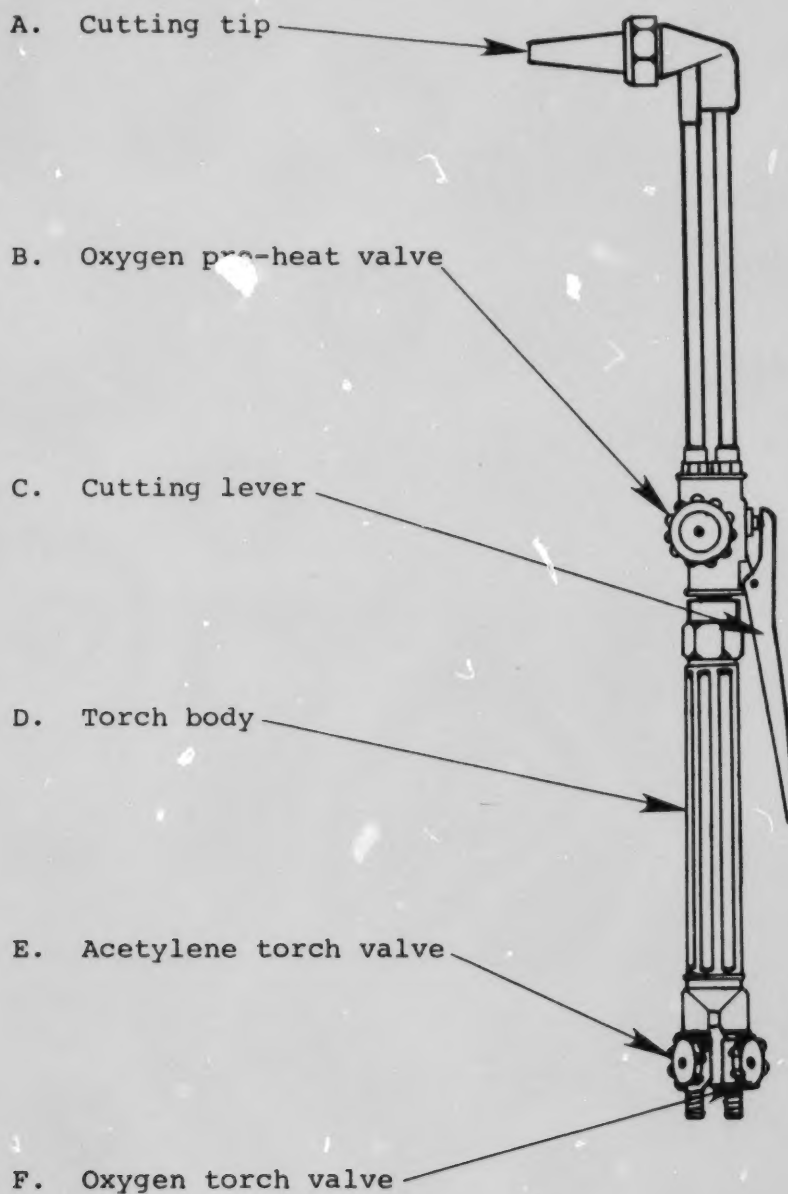
- A. Flame cutting--The process by which steel is removed by heating it to the melting point and then rapidly oxidizing it with pure oxygen under pressure
- B. Oxidizing--Combining oxygen with steel, forming a scale or slag
- C. Slag--The deposits or oxides left after a cut has been made
- D. Oxides--Rust, corrosion, scale coating, or slag
- E. Kerf--Area where metal was removed in the form of oxides during the cutting process
- F. Drag line--The lines formed on the metal being cut which appear to be lagging behind at the bottom of the cut
- G. Flashback--Fire burning inside the torch
- H. Backfire--A sudden burning of the flame back into the torch as the flame goes out with a "pop"
- I. Preheat time--Heating the metal at the starting point of a cut to its melting temperature
- J. Preheat orifice--A device used to combine the gases to produce a preheat flame
- K. Tip cleaners--A device with different-sized wires to remove carbon deposits from welding tips



UNIT III
USE OF THE CUTTING TORCH

INFORMATION SHEET #2--THE CUTTING TORCH

II. Parts of a Cutting Torch



UNIT III

USE OF THE CUTTING TORCH

INFORMATION SHEET #3--THE CUTTING PROCESS

- III. Hazards of Hot Slag
 - A. Will cause burns to body
 - B. Will burn hoses
 - C. Causes fires in clothing
 - D. Forms sharp edges on cut metal
 - E. Will cause concrete to explode
- IV. Causes of a backfire
 - A. Acetylene or oxygen pressure too low
 - B. Cutting tip nut loose
 - C. Slag or splatter on tip
 - D. Overheating the cutting tip
 - 1. Cutting in a tight corner
 - 2. Piercing a hole in thick metal
 - 3. Cutting in a recessed area
 - E. Faulty O-rings
 - F. Rust or dirt on metal being welded
- V. Results of a backfire
 - A. Flame momentarily burns inside tip
 - B. There is usually a loud pop
 - C. The flame sometimes goes out
 - D. The flame may continue to burn normally
- VI. Results of a flashback
 - A. A fire burning inside the torch

- B. The flame seems to go out
- C. A squealing or hissing noise begins
- D. Torch starts smoking and getting hot
- E. Torch will burn in half if flashback continues

NOTE: Immediately shut off torch by closing the oxygen valve and then the acetylene valve on the torch.

VII. Reasons for poor cuts

- A. Travel too fast



- B. Travel too slow



- C. Oxygen pressure too high



- D. Oxygen pressure too low



- E. Preheat flame too long



- F. Preheat flame too short



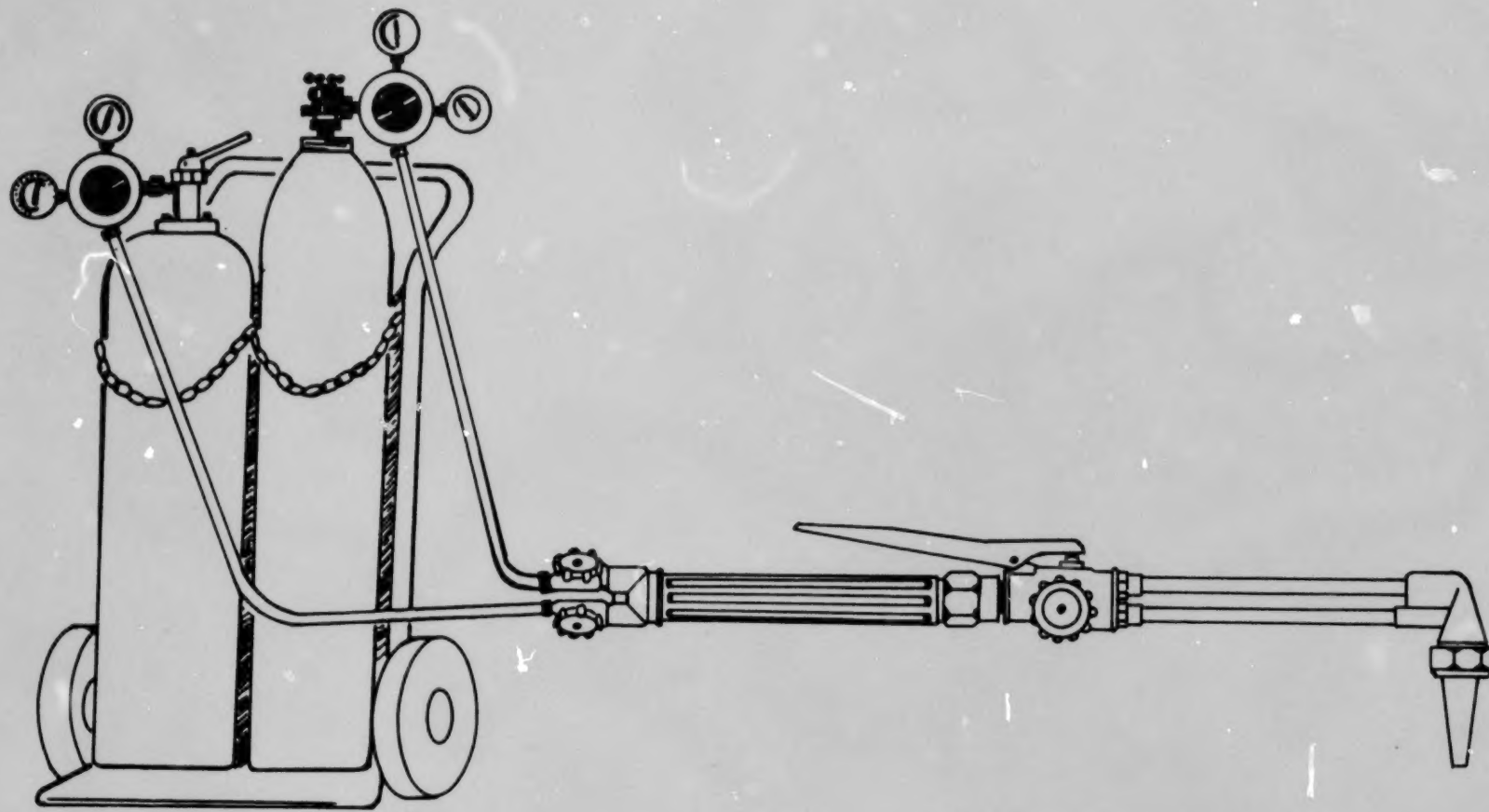
- G. Unsteady torch handling



- H. Cut was stopped and started poorly



CUTTING TORCH EQUIPMENT



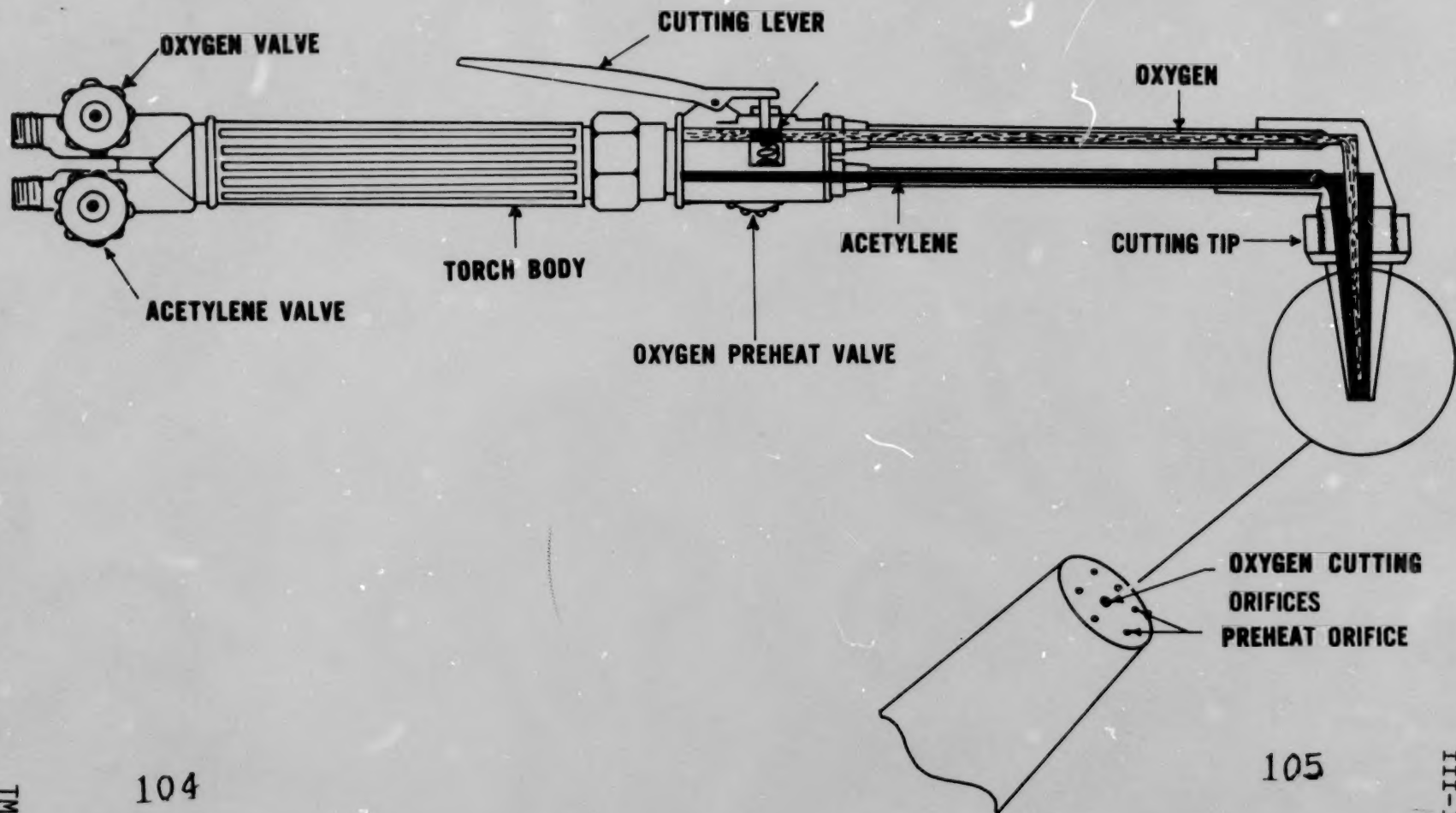
TM-1

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III-11

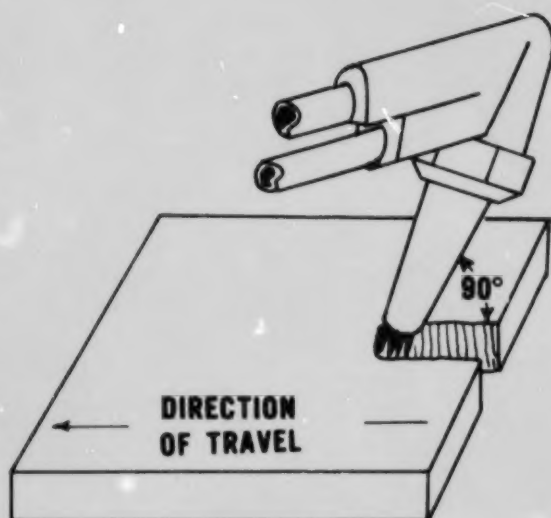
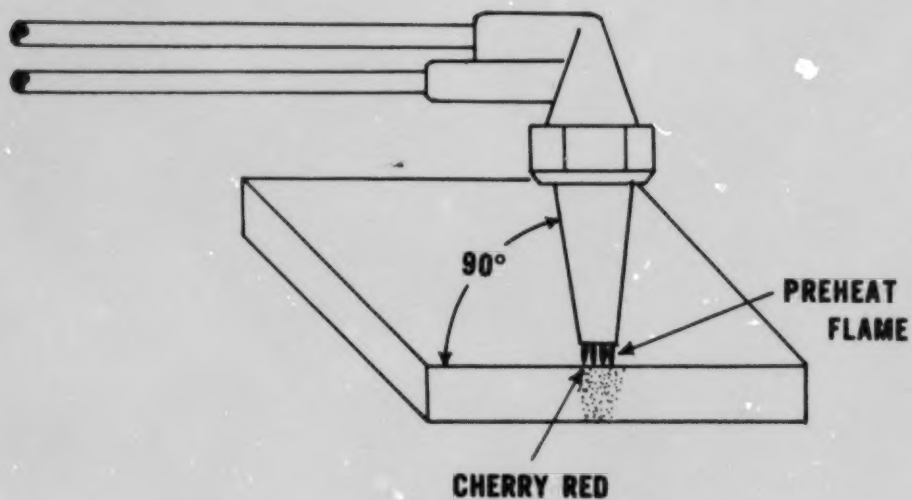
CUTTING TORCHES



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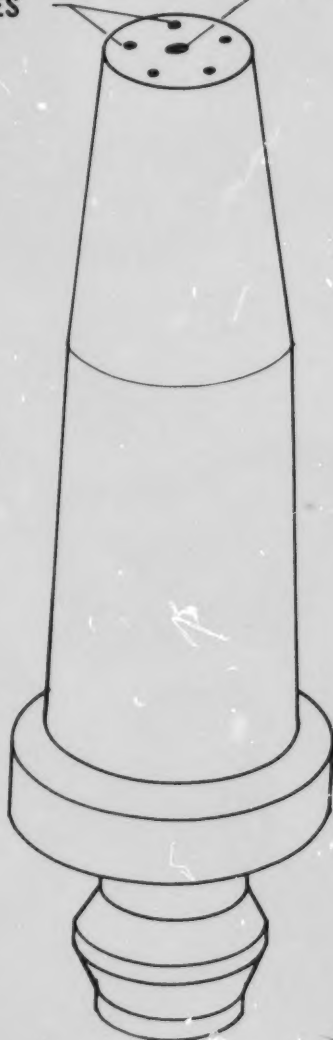
POSITIONING THE TORCH



TORCH TIPS

PREHEAT ORIFICES

CUTTING ORIFICE

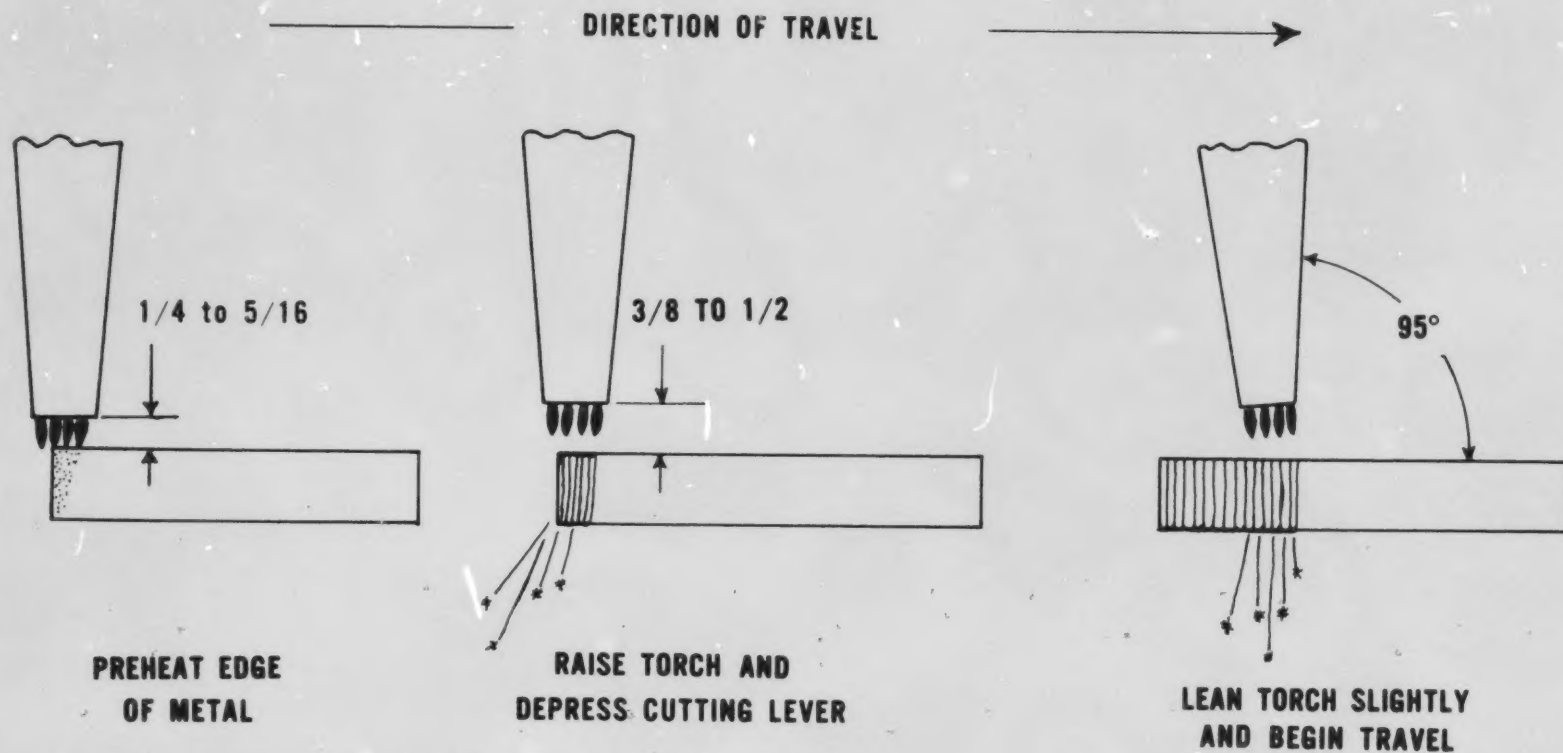


FOUR HOLE ORIFICE



FIVE HOLE ORIFICE

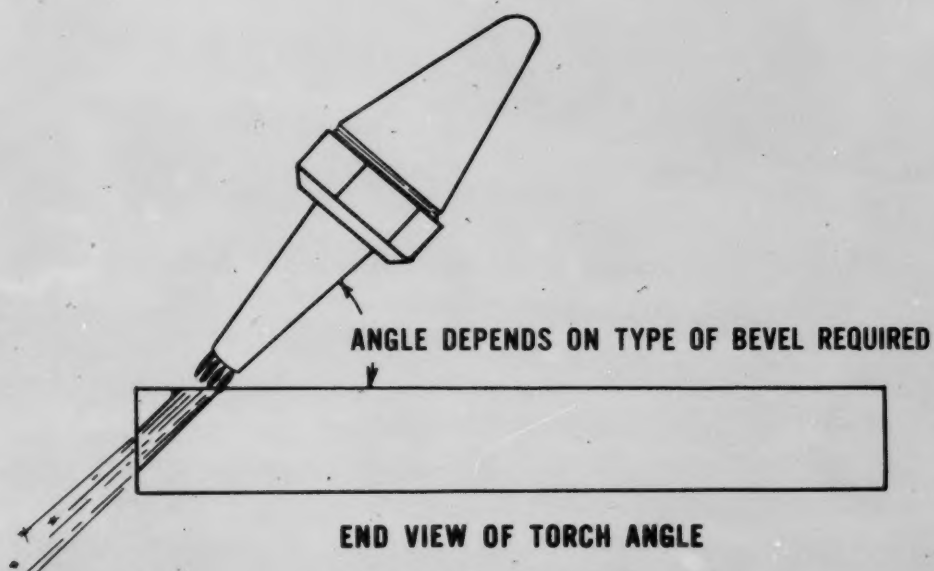
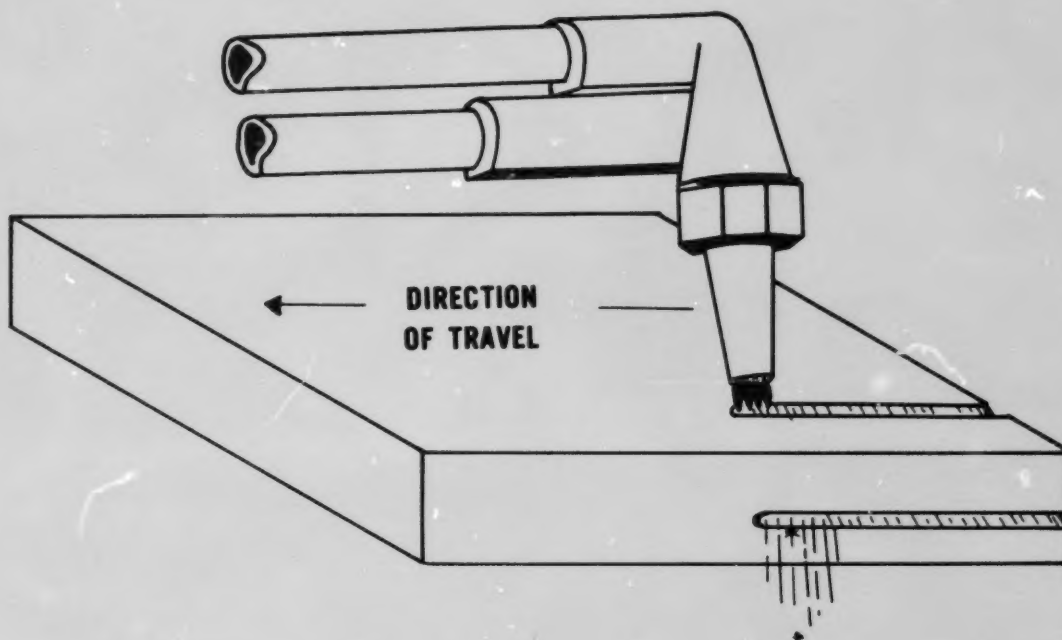
STEPS IN CUTTING



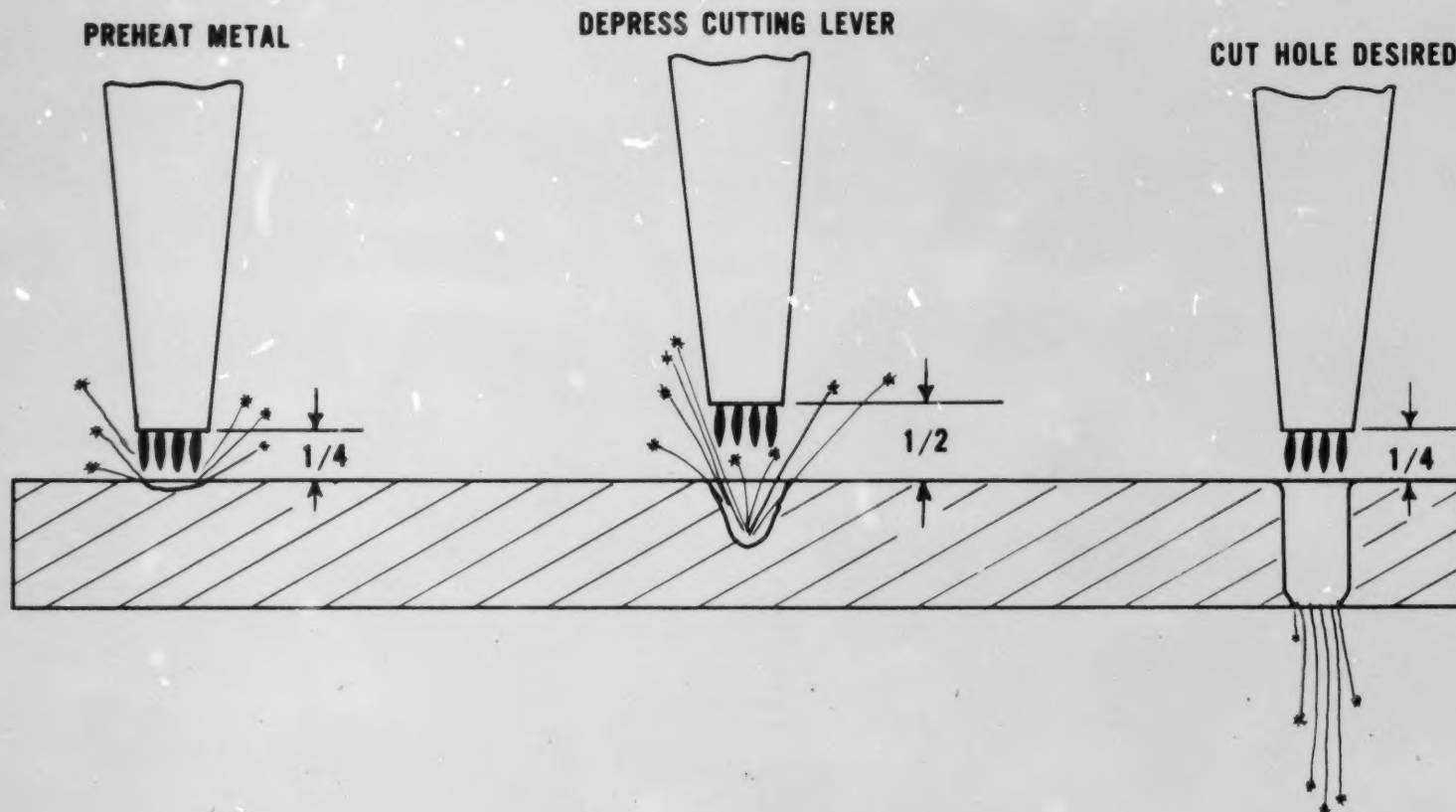
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CUTTING A BEVEL



PIERCING A HOLE

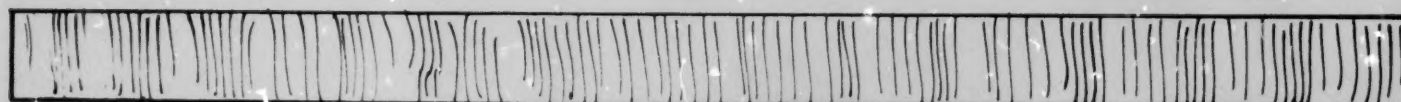


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III-23

EXAMPLES OF POOR TORCH CUTS

A GOOD CUT



PREHEAT FLAMES TOO SMALL



CUTTING SPEED TOO SLOW



PREHEAT FLAMES TOO LONG



CUTTING SPEED TOO FAST



OXYGEN PRESSURE TOO LOW



UNSTEADY TORCH HANDLING



OXYGEN PRESSURE TOO HIGH



CUT STOPPED AND STARTED POORLY



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UNIT III

USE OF THE CUTTING TORCH

JOB SHEET #1--TURN ON, LIGHT, ADJUST AND
TURN OFF OXYACETYLENE CUTTING TORCH

I. Tools and equipment required

- A. Oxyacetylene welding unit
- B. Cutting table
- C. Gloves
- D. Goggles
- E. Pliers
- F. Cooling vat
- G. Wire brush
- H. Cutting attachment
- I. Flint lighter
- J. Coveralls
- K. Chipping hammer

II. Procedure

- A. Put on oxyacetylene goggles, coveralls, and gloves
- B. If equipment is not already set up, refer to Unit I, Job Sheet #1--Setting up Oxyacetylene Equipment for Welding, for instructions.
- C. Check to make sure all torch and cylinder valves are closed
- D. Put cutting attachment on torch body.

(NOTE: All valves should be on the same side of the torch.)

- E. Slowly open acetylene cylinder valve one round
- F. Regulate the winged adjusting screw until the low pressure gauge reaches 5 PSI
- G. Slowly open the oxygen cylinder valve until pressure has stopped climbing on the high pressure gauge and then open the valve all the way
- H. Regulate the winged adjusting screw until the low pressure oxygen gauge reaches 20 PSI
- I. Using the flint lighter, light the torch by opening the acetylene torch valve 1/4 turn and striking the lighter in front of the tip
- J. Open acetylene valve until the flame nearly quits smoking
- K. Open oxygen valve all the way (leave open)
- L. Open the oxygen preheat valve slowly until a neutral flame has been reached. (There should be a group of clear inner cones in the flame.)



- M. Depress the cutting lever and see if the neutral flame remains
- N. If a feather appears on the inner cone, adjust the oxygen preheat valve until the neutral flame is reached while the lever is depressed
- O. To shut torch off, close acetylene torch valve first
- P. Close oxygen preheat valve
- Q. Close acetylene cylinder valve
- R. Open acetylene torch valve until both gauges reach zero
- S. Close acetylene torch valve
- T. Back out the winged adjusting screw until tension on the regulator is released
- U. Close oxygen cylinder valve

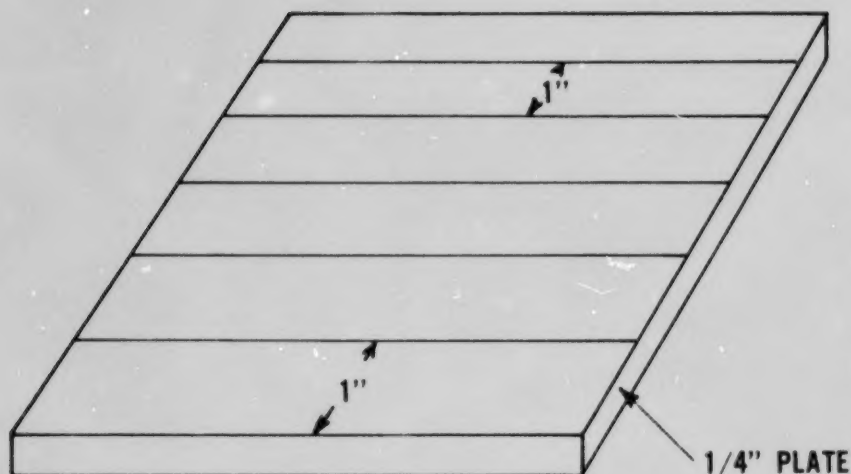
- V. Open torch oxygen valve until both gauges reach zero
- W. Close oxygen torch valve
- X. Back out the winged adjusting screw until the tension on the oxygen regulator is released
- Y. Roll up hoses on the welding cart or dolly and place torch where it will not be knocked off

UNIT III

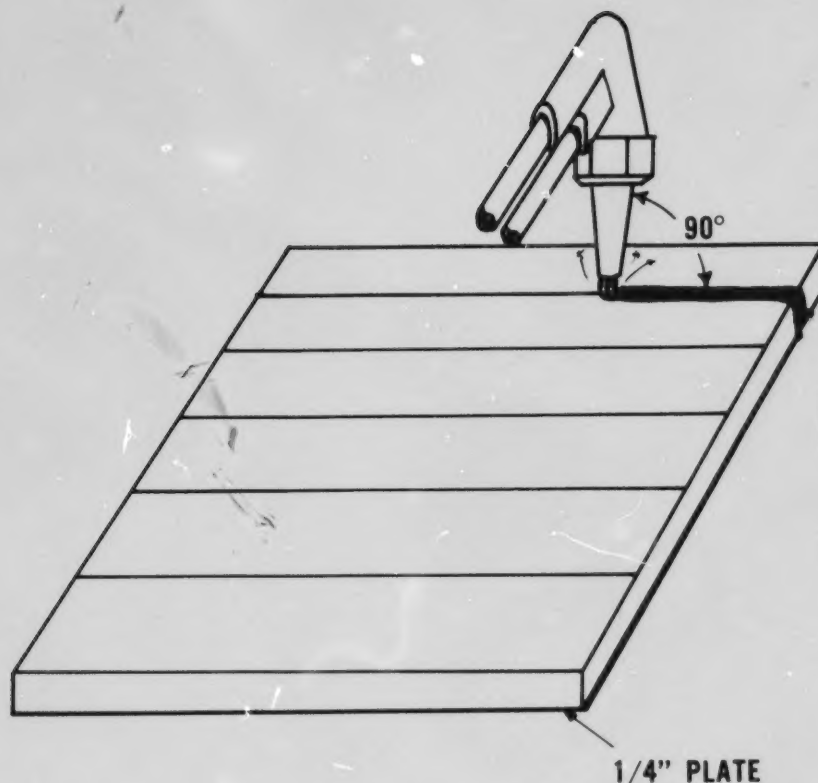
USE OF THE CUTTING TORCH

JOB SHEET #2--LAY OUT LINES ON A PIECE OF METAL
AND CUT WITH CUTTING TORCH AT 90° ANGLE

- I. Tools, equipment, and materials required
 - A. Trysquare
 - B. Soapstone
 - C. Oxyacetylene welding unit
 - D. Cutting table
 - E. Gloves
 - F. Goggles
 - G. Pliers
 - H. Cooling vat
 - I. Wire brush
 - J. Cutting attachment
 - K. Flint lighter
 - L. Coveralls
 - M. Chipping hammer
 - N. Tip cleaners
 - O. One piece of 1/4 inch steel plate (approximately 4 x 6 inches)
- II. Procedure
 - A. Using the try-square and soapstone, mark off 1-inch spaces down the 6-inch length on the plate
 - B. On each of these marks, draw a line across the 4-inch length of the plate with the try-square



- C. Place the plate on the cutting table in position to cut
- D. Put on oxyacetylene goggles, coveralls, and gloves
- E. Turn on oxyacetylene welding unit (5 PSI acetylene, 20 PSI oxygen)
- F. Light and adjust torch to a neutral flame
- G. Put hoses behind operator
- H. Hold cutting attachment with left hand and torch body with right hand
(NOTE: Reverse this for left handed students)
- I. Rest arm on table where cutting flame is in position to cut one of the soapstone lines and at 90° to the plate
- J. Hold the preheat flame with the inner cones 1/16 to 1/8 inch off of the plate at the right edge on the line
- K. When the metal reaches its melting point, depress the oxygen cutting lever and move steadily to the left across the plate, keeping the torch the same height



- L. If the cut stops, release oxygen cutting lever
- M. Preheat the edge where the cutting stopped
- N. Slowly depress the oxygen cutting lever and continue cutting
- O. Repeat cutting the soapstone lines on the metal until the process can be easily done
- P. Hold metal with pliers while cooling in a water vat
- Q. Shut down oxyacetylene welding unit and roll up hoses

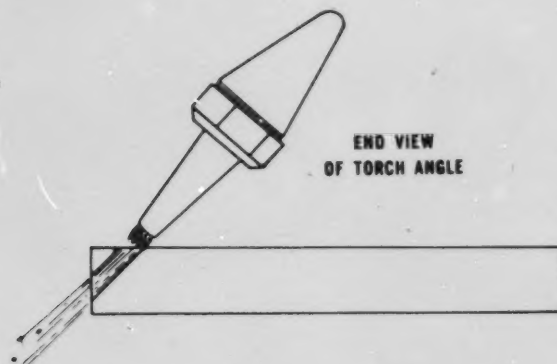
UNIT III

USE OF THE CUTTING TORCH

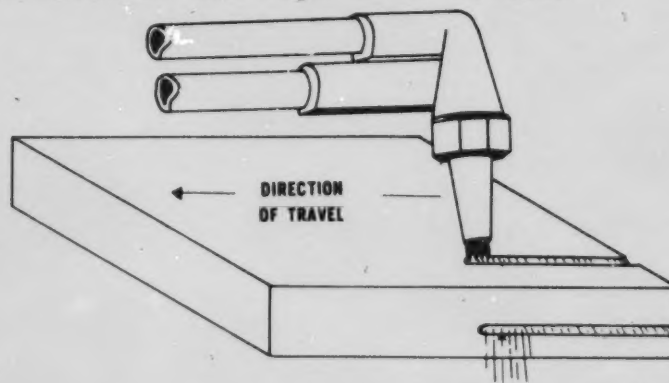
JOB SHEET #3--MAKE A 45° BEVELED CUT

- I. Tools, equipment, and materials required
 - A. Trysquare
 - B. Soapstone
 - C. Oxyacetylene welding unit
 - D. Cutting table
 - E. Gloves
 - F. Goggles
 - G. Pliers
 - H. Cooling vat
 - I. Wire brush
 - J. Cutting attachment
 - K. Flint lighter
 - L. Coveralls
 - M. Chipping hammer
 - N. Tip cleaners
 - O. Mild steel plate, 1/2 x 2 x 6 inches
- II. Procedure
 - A. Place metal on table and lay out a line along the edge of the metal, if necessary
 - B. Put on oxyacetylene goggles, coveralls, and gloves
 - C. Turn on oxyacetylene welding unit (5 PSI acetylene, 20 PSI oxygen)
 - D. Light and adjust torch to a neutral flame
 - E. Place hoses behind operator

- F. Holding the torch with both hands, bring the torch into cutting position with your arm resting on the table
- G. Place torch at about a 45° angle and about 3/8 inch from the metal's edge to be beveled. The torch will be in line with the direction of the cut



- H. Hold the preheat flame with the inner cones 1/16 to 1/8 inch off of the plate and heat to its melting point
- I. Depress the cutting lever and move steadily across the metal on the edge to be beveled



- J. Keep the same height and cutting angle the full distance of the cut
- K. Repeat this process until it becomes easily done
- L. Cool metal and remove slag or burrs with chipping hammer
- M. Shut down oxyacetylene welding unit and roll up hoses

UNIT III

USE OF THE CUTTING TORCH

JOB SHEET #4--CUT A HOLE IN STEEL PLATE

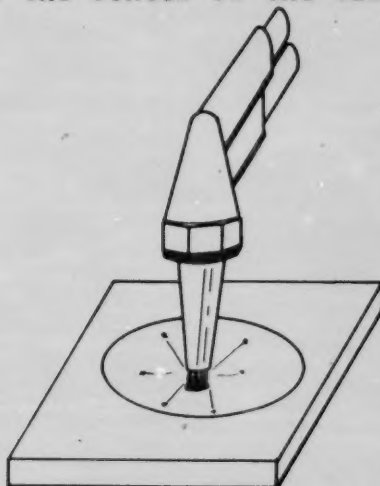
I. Tools, equipment, and materials required

- A. Trysquare
- B. Soapstone
- C. Oxyacetylene welding unit
- D. Cutting table
- E. Gloves
- F. Goggles
- G. Pliers
- H. Cooling vat
- I. Wire brush
- J. Cutting attachment
- K. Flint lighter
- L. Coveralls
- M. Chipping hammer
- N. Tip cleaners
- O. Mild steel plate, 1/4 x 4 x 6 inches

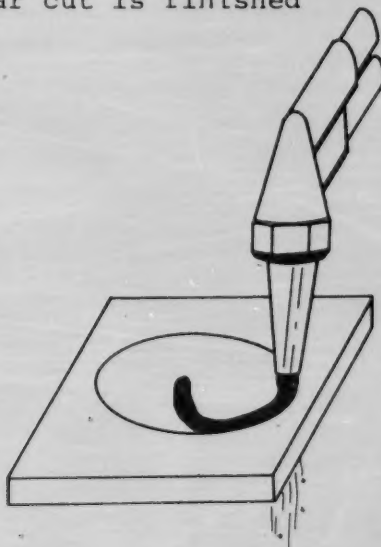
II. Procedure

- A. Lay out a circle, with a radius of about 1 inch, on the plate metal and lay the plate on the cutting table in position to cut
- B. Put on oxyacetylene goggles, coveralls, and gloves
- C. Turn on oxyacetylene welding unit (5 PSI acetylene, 20 PSI oxygen)
- D. Light and adjust torch to a neutral flame

- E. Move hoses behind operator
- F. Holding torch with both hands, move into a comfortable position with the torch in center of the circle on the plate
- G. Hold torch where the inner cones are $\frac{1}{16}$ to $\frac{1}{8}$ inch above the center of the circle



- H. When the metal reaches its melting point, depress the cutting lever and raise the torch about $\frac{1}{2}$ inch
- I. As the molten metal forms, move the torch slightly to one side until the cut pierces the plate
- J. Move the torch steadily over to the soapstone marks and follow the inside edge of the line until the circular cut is finished



- K. Repeat this process until it can be easily done
- L. Hold plate with pliers and dip in cooling vat
- M. Remove slag with chipping hammer
- N. Turn off oxyacetylene welding unit and roll up hoses

UNIT III

USE OF THE CUTTING TORCH

TEST--PART 1

1. Match the following terms and definitions:

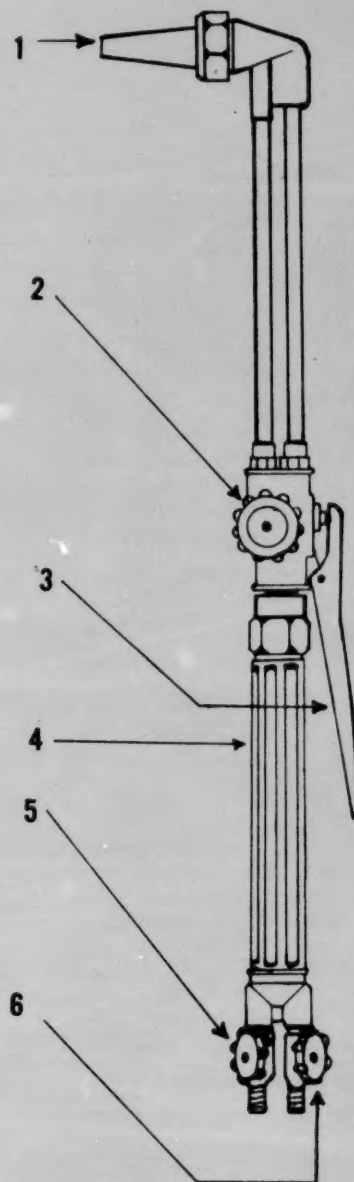
- | | |
|--------------------------|--|
| _____ a. Oxidizing | 1. A sudden burning of the flame back into the torch as the flame goes out with a pop |
| _____ b. Tip cleaners | 2. The process by which steel is removed by heating to the melting point and then rapidly oxidizing it with pure oxygen under pressure |
| _____ c. Preheat time | 3. Combining of oxygen with steel forming a scale or slag |
| _____ d. Oxides | 4. The deposits or oxides left after a cut has been made |
| _____ e. Drag lines | 5. Rust, corrosion, scale coating, or slag |
| _____ f. Backfire | 6. Area where metal was removed in the form of oxides during the cutting process |
| _____ g. Preheat orifice | 7. The lines formed on the metal being cut which appear to be lagging behind at the bottom of the cut |
| _____ h. Flame cutting | 8. A fire burning inside the torch |
| _____ i. Slag | 9. Heating the metal at the starting point of a cut to its melting temperature |
| _____ j. Kerf | 10. A device used to combine the gases to produce a preheat flame |
| _____ k. Flashback | 11. A device with different sized wires to remove carbon deposits from welding tips |

UNIT III
USE OF THE CUTTING TORCH

TEST--PART 2

2. Identify the parts of the torch body and cutting attachment by placing the correct number to the left of the letter.

- ___ a. Torch body
- ___ b. Cutting tip
- ___ c. Acetylene torch valve
- ___ d. Cutting lever
- ___ e. Oxygen torch valve
- ___ f. Oxygen pre-heat valve



UNIT III

USE OF THE CUTTING TORCH

TEST--PART 3

3. Point out the hazard of hot slag by answering yes or no to each of the following statements.
- ☐ a. Hot slag gives off radiation.
 - ☐ b. Hot slag will cause burns to the body.
 - ☐ c. Hot slag takes days to cool.
 - ☐ d. Slag will burn hoses.
 - ☐ e. Hot slag will cause concrete to explode.
 - ☐ f. Hot slag causes fire on clothing.
4. Place a "✓" in front of any following phrases that identify causes of backfires.
- ☐ a. Moisture in the air
 - ☐ b. Acetylene or oxygen pressure too low
 - ☐ c. Cutting tip nut loose
 - ☐ d. Overheating the cutting tip
 - ☐ e. Improper weave pattern
 - ☐ f. Faulty O-rings
 - ☐ g. Rust or dirt on metal being welded
5. Describe the results of a backfire by circling the correct answer in each of the following.
- a. The flame burns inside the tip (for hours, momentarily.)
 - b. There is usually a loud (pop, explosion.)
 - c. The flame sometimes (gets big, goes out.)
 - d. The flame may continue to burn (normally, out of control.)

6. Describe the results of a flashback by circling the correct answer in each of the following.
- A fire is burning (around the tip, inside the torch.)
 - The flame seems (to go out, to get larger.)
 - A squealing or hissing noise means the flash back is (over, beginning.)
 - Torch starts (smoking, shaking) and getting (hot, cold.)
 - The torch will (quit burning, burn in half) if a flashback continues.
7. Determine the reasons for poor torch cuts by placing the letter of the reason next to the correct torch cut illustration.

- | | | |
|----------|---|-----------------------------------|
| _____ a. |  | 1. Oxygen pressure too high |
| _____ b. |  | 2. Unsteady torch movement |
| _____ c. |  | 3. Cutting speed fast |
| _____ d. |  | 4. Cutting speed slow |
| _____ e. |  | 5. Cut stopped and started poorly |
| _____ f. |  | 6. Oxygen pressure too low |
| _____ g. |  | 7. Preheat flames too long |
| _____ h. |  | 8. Preheat flames too small |

8. Demonstrate the ability to:
- a. Turn on, light, adjust, and turn off the oxyacetylene cutting torch.
 - b. Lay out lines on a piece of metal and cut with cutting torch at a 90° angle.
 - c. Make a 45° beveled cut.
 - d. Cut a hole in steel plate.

UNIT III
USE OF THE CUTTING TORCH

ANSWERS TO TEST

PART 1

- | | | |
|----|--------------|--------------|
| 1. | <u>3</u> a. | <u>10</u> g. |
| | <u>11</u> b. | <u>2</u> h. |
| | <u>9</u> c. | <u>4</u> i. |
| | <u>5</u> d. | <u>7</u> j. |
| | <u>7</u> e. | <u>8</u> k. |
| | <u>1</u> f. | |

PART 2

- | | | |
|----|-------------|-------------|
| 2. | <u>4</u> a. | <u>3</u> d. |
| | <u>1</u> b. | <u>6</u> e. |
| | <u>5</u> c. | <u>2</u> f. |

PART 3

- | | | |
|----|---------------|---------------|
| 3. | <u>no</u> a. | <u>yes</u> d. |
| | <u>yes</u> b. | <u>yes</u> e. |
| | <u>no</u> c. | <u>yes</u> f. |

PART 4

- | | | |
|----|----------------|----------------|
| 4. | <u> </u> a. | <u> </u> e. |
| | <u>✓</u> b. | <u>✓</u> f. |
| | <u>✓</u> c. | <u>✓</u> g. |
| | <u>✓</u> d. | <u>✓</u> h. |

PART 5

5. a. momentarily

b. pop

c. goes out

d. normally

6. a. inside the torch

b. to go out

c. beginning

d. smoking, hot

e. burn in half

7. 8 a.

7 b.

6 c.

1 d.

4 e.

3 f.

2 g.

5 h.

8. Evaluated to the satisfaction of the instructor.

UNIT IV

INTRODUCTION TO SHIELDED METAL ARC WELDING

UNIT OBJECTIVE

After completion of this unit of instruction, the student will be able to relate briefly the history of the arc welder. The student will be able to identify welders, welding equipment, types of welds, types of joints, different electrodes, and the welding positions used in arc welding. The student will be able to discuss the fundamentals of arc welding and choose proper safety precautions. This knowledge will be evidenced through demonstration and by satisfactorily completing a unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student will be able to:

1. Discuss briefly the history of shielded metal arc welding.
2. Match the terms and definitions associated with arc welding.
3. Identify three types of arc welders.
4. Explain how welder adjustments affect heat produced and current direction.
5. Select the special uses of the arc welder.
6. Identify each part of arc welding equipment.
7. Select the proper lens and sequence for installation in the welding helmet.
8. Select the proper safety procedure in each of the hazardous areas relating to arc welding.
9. Point out the types of electrodes.
10. Identify each of the American Welding Society specifications of an electrode.
11. List two factors to remember in determining electrode sizes.
12. Name the purposes of flux.

13. Identify each of the welding positions.
14. Identify each of the weld joints.
15. Identify each of the parts of a fillet weld.
16. Identify each of the terms associated with the welding process.

UNIT IV

INTRODUCTION TO SHIELDED METAL ARC WELDING

SUGGESTED ACTIVITIES

I. Instructor

- A. Provide students with activity sheet.
- B. Provide students with information sheets.
- C. Make transparencies.
- D. Discuss unit and specific objective.
- E. Discuss information sheet.
- F. Give test.

II. Student

- A. Read objective
- B. Study information sheets
- C. Take test

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objective sheet
- B. Information sheets
 - 1. Information Sheet #1--History and Terminology of Arc Welding
 - 2. Information Sheet #2--The Arc Welder and Equipment
 - 3. Information Sheet #3--Arc Welding Safety
 - 4. Information Sheet #4--The Electrode
 - 5. Information Sheet #5--The Weld

C. Transparency masters

1. TM-1--Protective Equipment
2. TM-2--Welding Safety
3. TM-2A--Arc Welding Radiation Can Burn
4. TM-3--Welding Equipment
5. TM-4--Electrode Coding
6. TM-5--Arc Welding Positions
7. TM-6--Joints and Welds
8. TM-7--Piercing, Couging, and Beveling
9. TM-8--Helmet Lens Istallation
10. TM-9--DC Polarity
11. TM-10--AC Welder

D. Test

E. Answers to test

II. References

- A. Althouse, Andrew D., Carl H. Turnquist and William A. Bowditch. Modern Welding. South
- B. Barton, Joel R., and C. B. Edwards. Farm Arc Welding Procedures. College Station, Texas: Teaching Materials Center, 1969.
- C. Department of Practical Arts and Vocational-Technical Education. Welding Skills and Technology. Columbia, Missouri: University of Missouri, n.d.
- D. Pender, James A. Welding. New York: McGraw-Hill Company, 1968.
- E. State Department of Vocational and Technical Education. General Mechanical Curriculum Guide. Stillwater, Oklahoma: Curriculum and Instructional Materials Center, 1973.
- F. Wakeman, T. J. The Farm Shop. New York: The McMillan Co., 1960.
- G. Walker, John R. Arc Welding and Basic Fundamentals. South Holland, Illinois: The Goodheart-Willcox Company, Inc., n.d.

UNIT IV

INTRODUCTION TO SHIELDED METAL ARC WELDING

INFORMATION SHEET #1--HISTORY AND TERMINOLOGY OF ARC WELDING

I. History

- A. Welding with an electric arc was developed at the end of the 19th century
- B. Electric arc welding was first used in 1881 by a French inventor to join parts of a storage battery
- C. Introduction of arc welding in the U.S. failed because people were not aware of the possibilities
- D. Carbon arc welding was patented in 1887 by a Russian inventor
- E. Coated welding rods were introduced in 1929
- F. Coatings were improved to keep out oxygen and nitrogen and form a stronger weld

II. Terms and definitions

- A. Shielded metal arc welding--A welding process that joins metals by heating with an electric arc jumping from a coated electrode to the metal
- B. Arc--The flow of electric current from the tip of the electrode to the metal being welded
- C. Electrode--A bar of flux-coated rod that is melted into the metal being welded by heat from an electric arc
- D. Flux--A material that is used in brazing and welding to allow the molten metal to fuse to the metal being welded and to keep out impurities
- E. Base metal--The metal to be welded
- F. Filler metal--Metal added to the weld to produce buildup
- G. Deposited metal--The buildup of a metal on the weld
- H. Crater--The depression at the end of a weld

- I. Arc length--Distance from the end of the rod to the base metal being welded
- J. AC (Alternating Current) Welder--A unit for welding in which the current changes direction 120 times a second
- K. DC (Direct Current) Welder--A unit for welding in which the current travels in one direction only
- L. Amperage--The measurement for electric current
- M. AWS--American Welding Society

UNIT IV

INTRODUCTION TO SHIELDED METAL ARC WELDING

INFORMATION SHEET #2--THE ARC WELDER AND EQUIPMENT

III. Types of Welders

- A. AC Welder--A transformer-type of welder producing alternating current
- B. DC Welder--A motor or engine driven generator producing direct current
- C. AC-DC Welder--A transformer rectifier producing either type of current

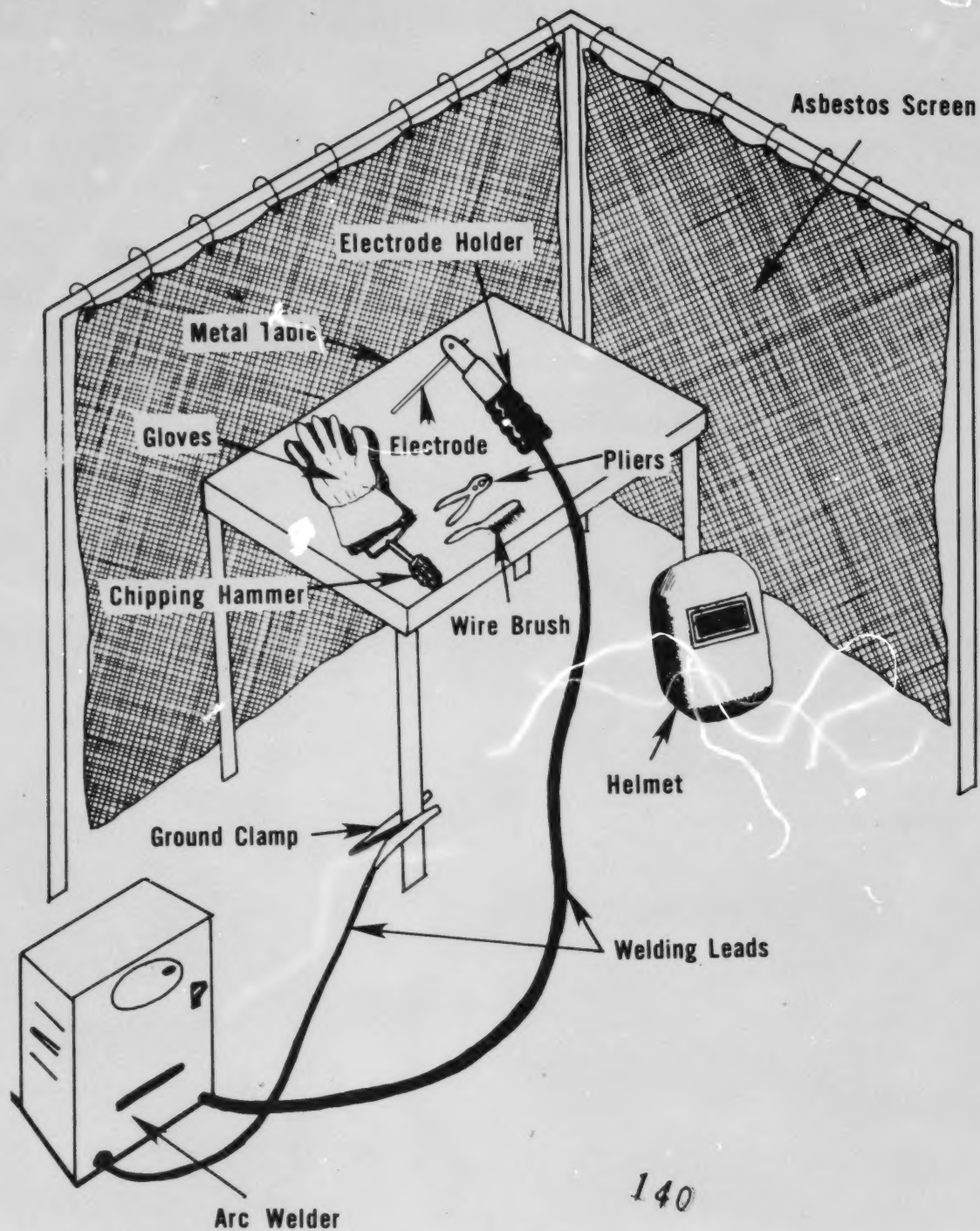
IV. Welding machine adjustments

- A. Current setting (amperage)
 - 1. Increase amperage to produce more heat
 - 2. Decrease amperage to produce less heat
- B. Polarity
 - 1. Reverse polarity allows current to flow from base metal to electrode
 - 2. Straight polarity allows current to flow from electrode to base metal

V. Special uses for the arc welder

- A. Cutting can be done with special rods
- B. Hole piercing
- C. Gouging or removing metal
- D. Beveling metal edges

VI. Arc Welding Equipment

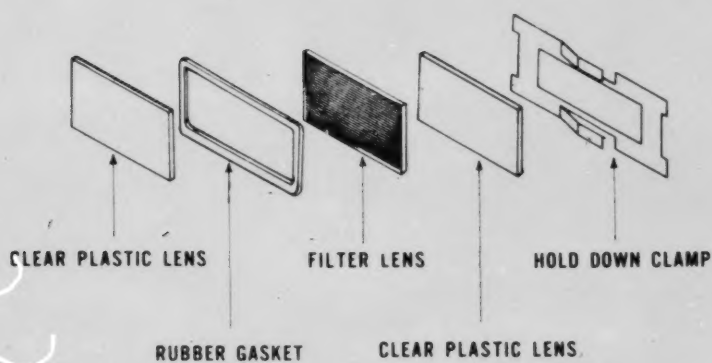
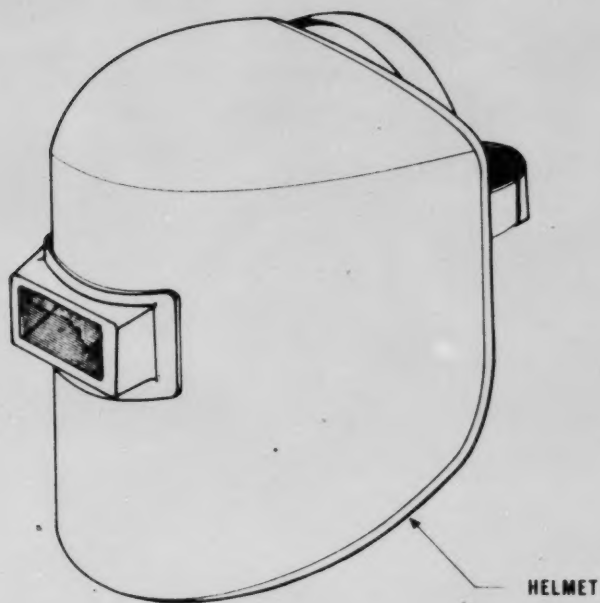


VII. Welding Lens

A. Colored lens (#10 lens is recommended)

B. Clear plastic or glass

EXAMPLE:



UNIT IV

INTRODUCTION TO SHIELDED METAL ARC WELDING

INFORMATION SHEET #3--ARC WELDING SAFETY

VIII. Safety

A. Electrical shock

1. Properly ground the arc welder
2. Keep the welder in a cool, dry location
3. Do not leave cables where they can be run over by other equipment or machinery
4. When welding, do not stand on wet surfaces or in water
5. Use electrode holders that are well insulated and free from cracks
6. Wear leather gloves that are in good condition

B. Radiation

1. The face and eyes should be covered with an arc welding helmet or shield
2. Any exposed skin surface should be covered to prevent burns from the ultraviolet and infrared rays
3. A verbal warning should be given to all persons in the area before striking an arc
4. Examine the helmet for cracks that will allow light to enter
5. Replace any cracked helmet lens
6. Do not wear oxyacetylene goggles when arc welding

C. Protective clothing

1. Wear high-top shoes
2. Do not wear pants with cuffs

3. Shirts should have long sleeves and button-up collars
4. Wear welding gloves of leather
5. Leather welding sleeves should be worn when available
6. Leather aprons should be worn when available
7. Safety glasses should be worn when chipping or cleaning welds

D. Fumes and gases

1. Toxic gases are formed when welding galvanized metal
2. Fans or adequate ventilation should be used to eliminate these gases
3. Avoid welding on containers or metal that have contained chemicals or been painted

E. Combustable materials

1. Remove all oily rags or greasy materials from the welding area
2. Do not weld on containers that have held a combustable substance

F. Hot metals

1. Handle hot metal with pliers
2. Stand to one side when dropping hot metal into a cooling vat because hot steam will be given off
3. Molten metal splatter from welding can cause serious burns if skin is not properly protected

UNIT IV

INTRODUCTION TO SHIELDED METAL ARC WELDING

INFORMATION SHEET #4--THE ELECTRODE

IX. Types of electrodes

- A. Mild steel
- B. Low hydrogen
- C. Stainless steel
- D. Cast iron
- E. Hard surfacing
- F. Non-ferrous

X. Electrode Classification

- A. Standardized by the AWS (American Welding Society)
(EXAMPLE: E plus four numbers E-6011)
- B. E stands for electrodes
- C. The first two digits identify the tensile strength of the deposited metal
- D. Third digit indicates the welding position
 - 1. A number 1 here indicates all positions
 - 2. A number 2 here indicates flat positions only
(NOTE: horizontal or downhand)
- E. The forth digit indicates electrical characteristics of the electrode
(NOTE: Refer to a pocket guide for specifications)
 - 1. Current used
 - a. AC
 - b. DC straight
 - c. DC reverse

2. Type of flux coating

3. Penetration

XI. Electrode sizes

- A. Determined by the diameter of the bare metal rod
- B. Range from 1/32 to 5/16 inch in thirty-seconds
- C. Common sizes 3/32, 1/8, 5/32, 3/16, 7/32, 1/6, 5/16 inch

XII. Purposes of flux

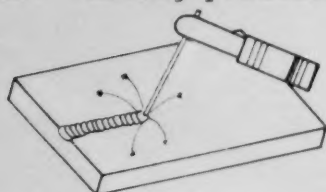
- A. Keeps air out of the molten puddle
- B. Allows weld to cool more slowly, which makes the weld stronger
- C. Removes impurities from weld puddle
- D. Stabilizes the arc
- E. Prevents porousness of weld metal
- F. Adds alloys to weld metal for strength
- G. Allows a faster deposit rate

UNIT IV

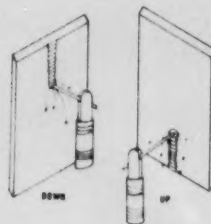
INTRODUCTION TO SHIELDED METAL ARC WELDING

INFORMATION SHEET #5--THE WELD

XIII. Welding positions



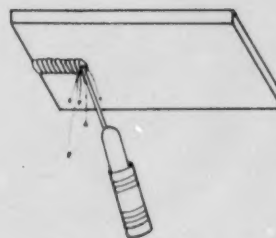
Flat



Vertical

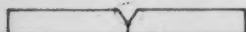


Horizontal

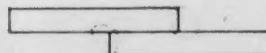


Overhead

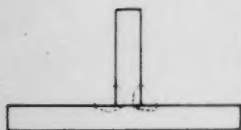
XIV. Weld Joints



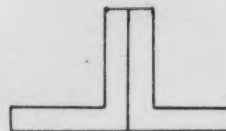
Butt Joint



Lap Joint

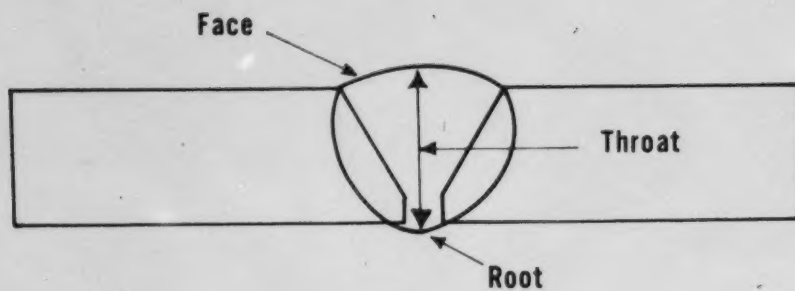


Tee Joint

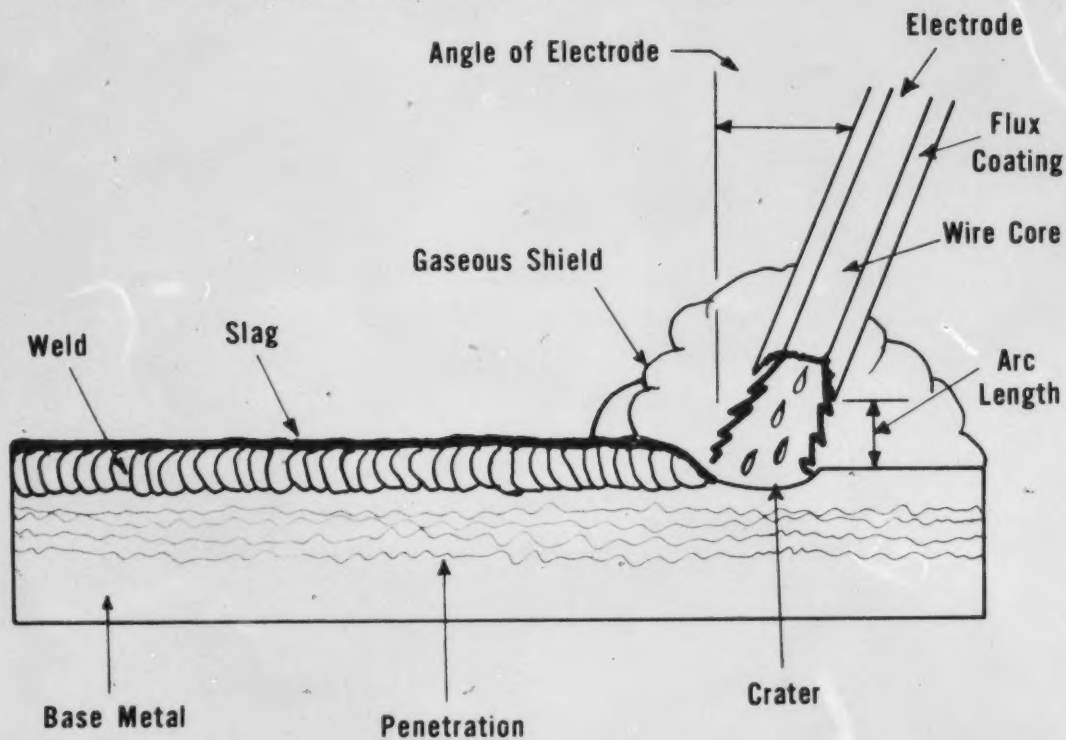


Edge Joint

XV. Parts of a Fillet Weld



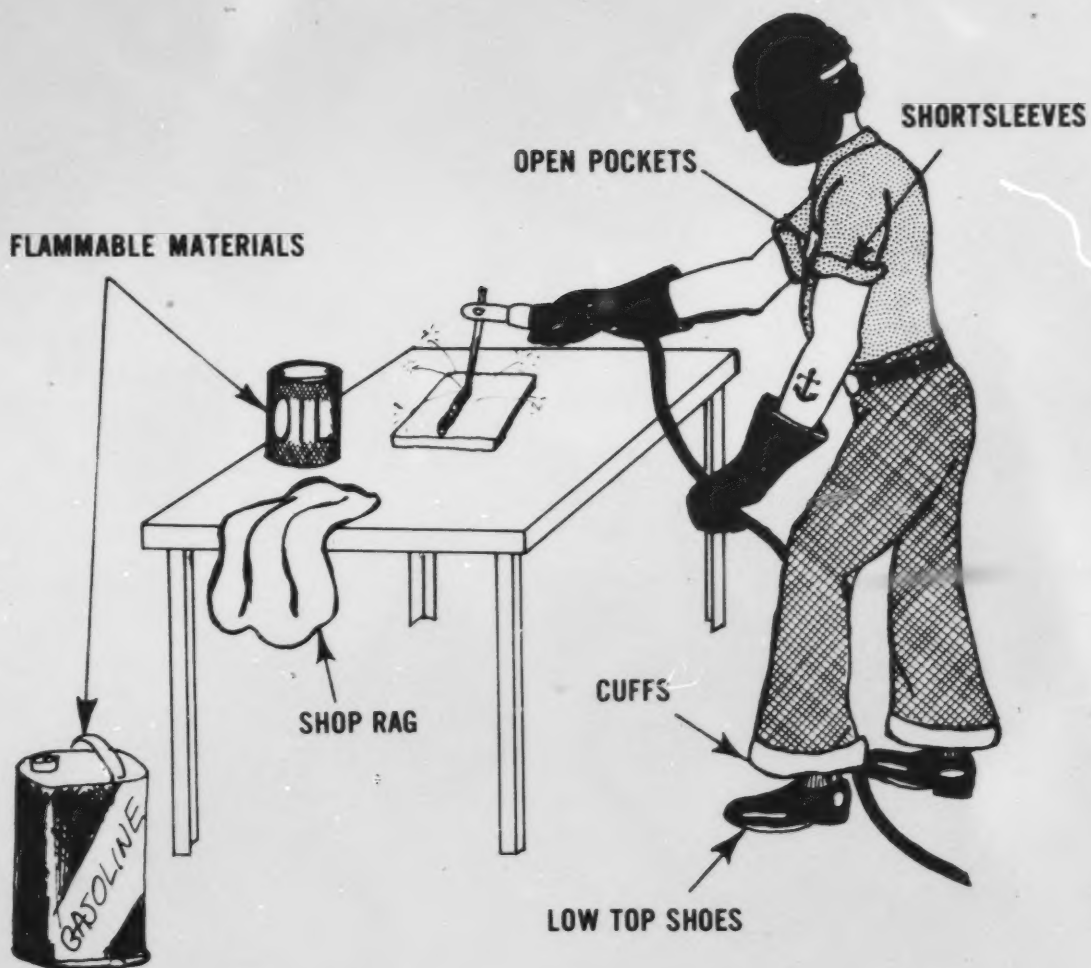
XVI. Terms associated with the welding process



PROTECTIVE EQUIPMENT

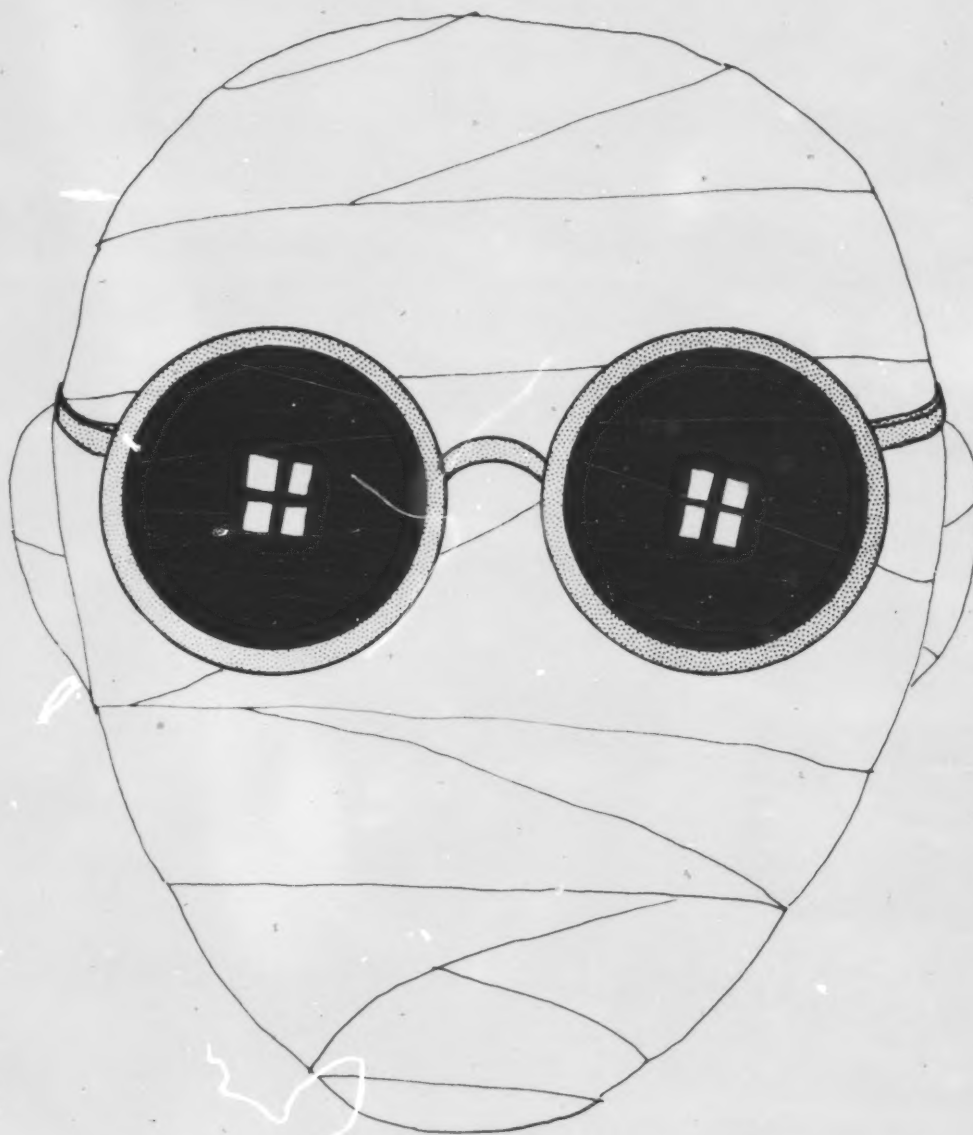


WELDING SAFETY



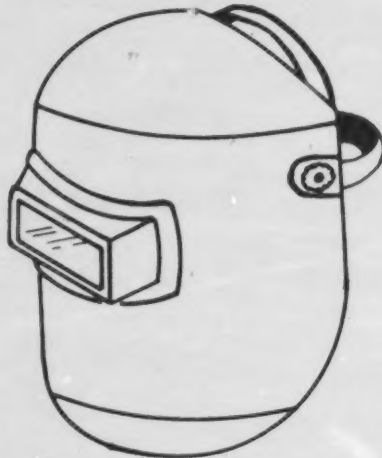
PROBLEM AREAS IN WELDING

ARC WELDING RADIATION CAN BURN!



Always Use A Welding Helmit or Shield

WELDING EQUIPMENT



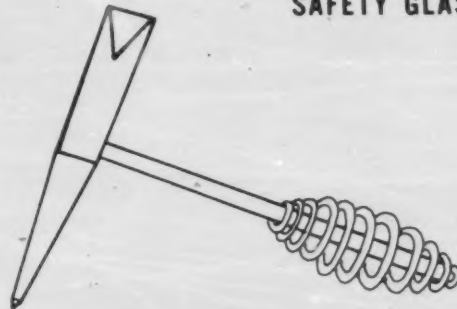
HELMET



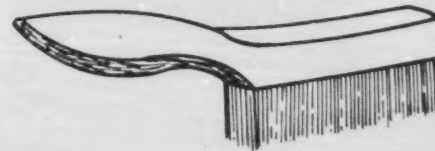
SAFETY GLASSES



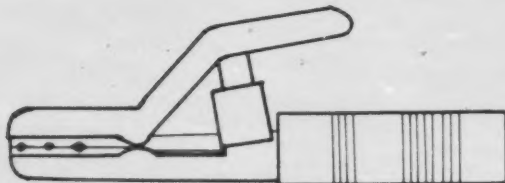
GLOVES



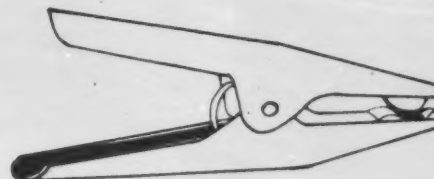
CHIPPING HAMMER



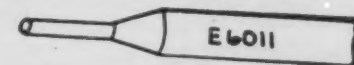
WIRE BRUSH



ELECTRODE HOLDER

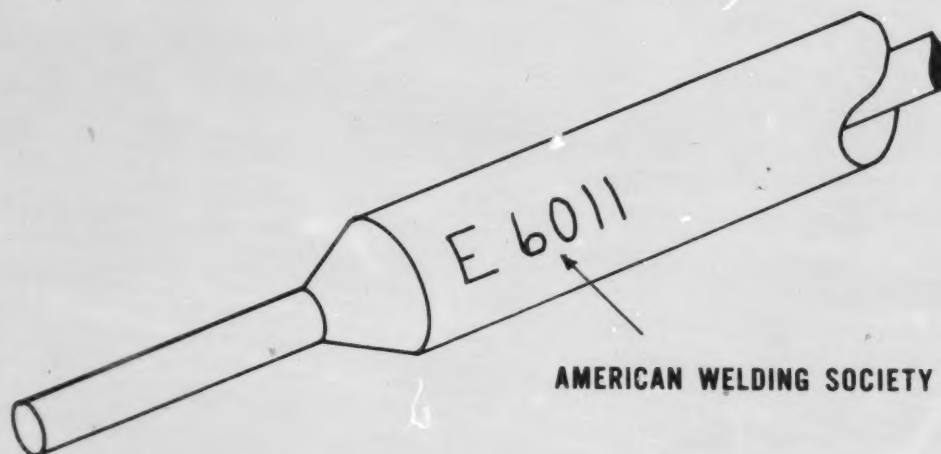


GROUND CLAMP



ELECTRODE

ELECTRODE CODING



AMERICAN WELDING SOCIETY NUMBER

E 6 0 1 1

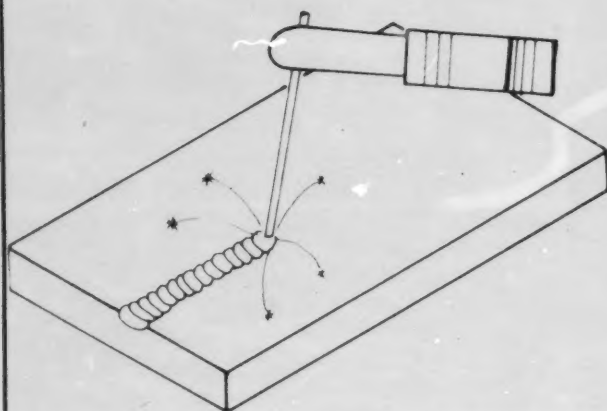
ELECTRIC WELDING

TENSIL STRENGTH
IN THOUSANDS OF POUNDS
PER SQUARE INCH

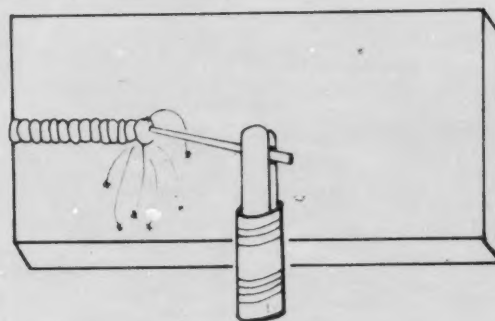
WELDING POSITION
1- ALL POSITIONS
2- FLAT AND HORIZONTAL

SPECIAL CHARACTERISTICS
PENETRATION
TYPE OF FLUX COATING

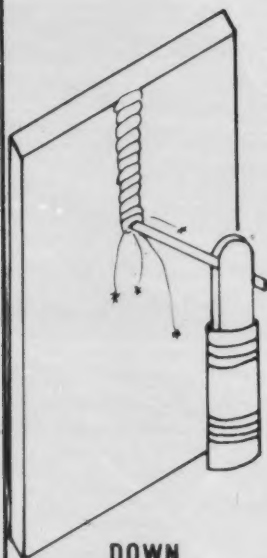
WELDING POSITIONS



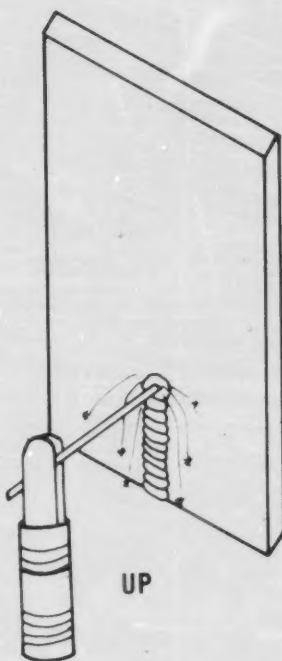
FLAT



HORIZONTAL

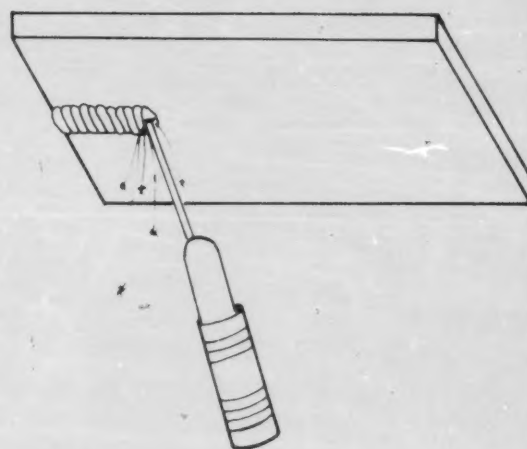


DOWN



UP

VERTICAL



OVERHEAD

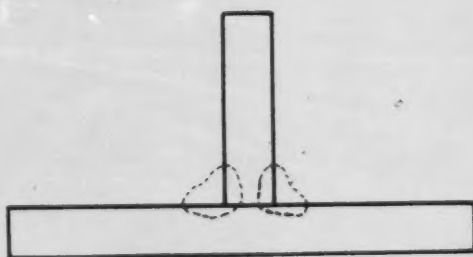
JOINTS AND WELDS



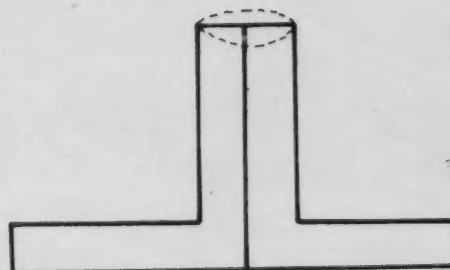
BUTT JOINT



LAP JOINT

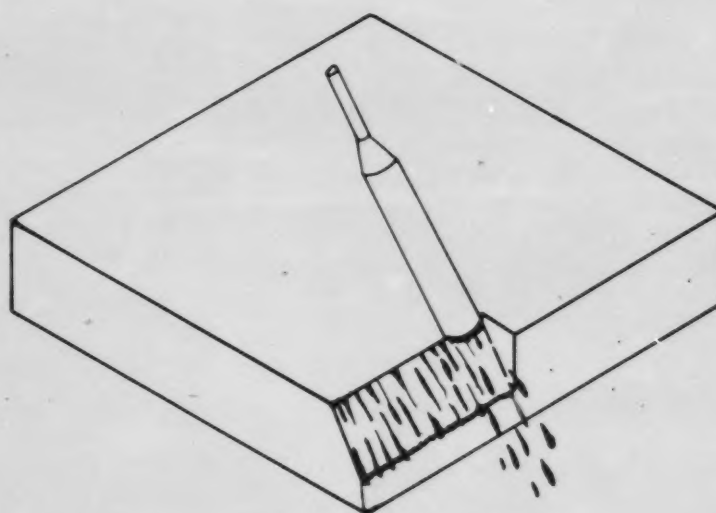
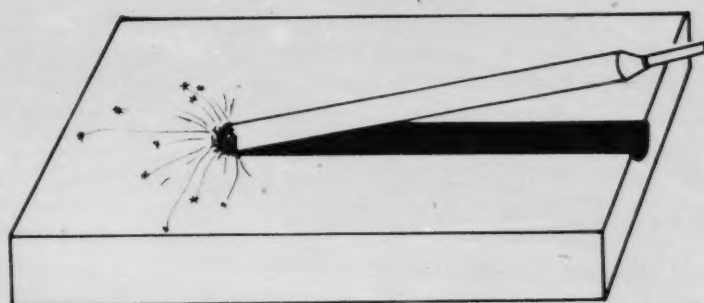
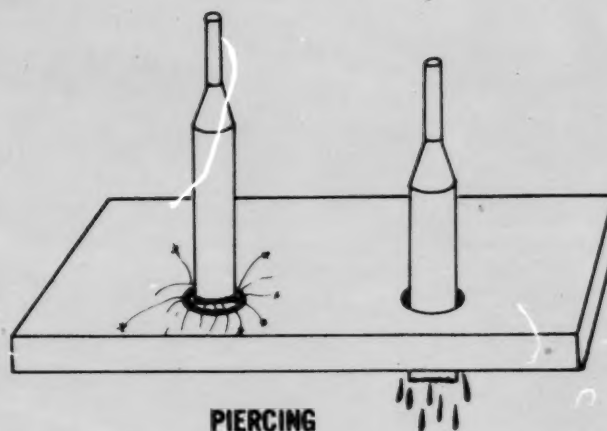


TEE JOINT

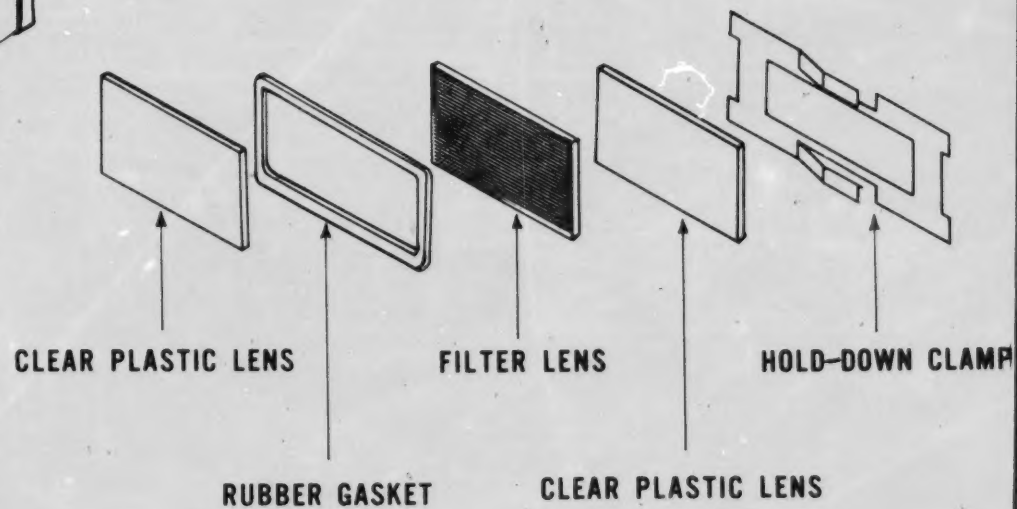
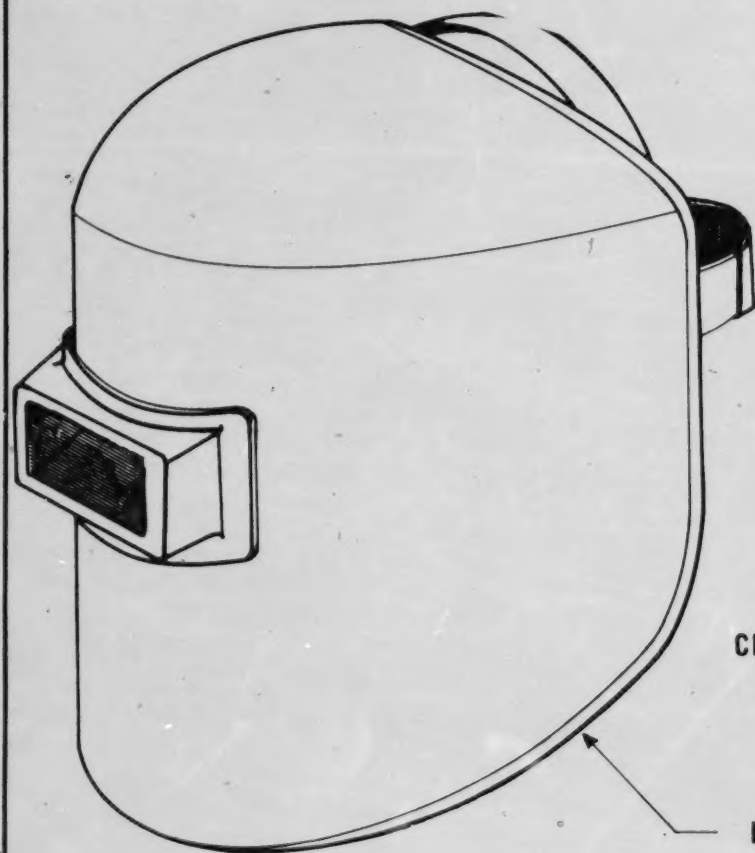


EDGE JOINT

PIERCING, GOUGING, AND BEVELING

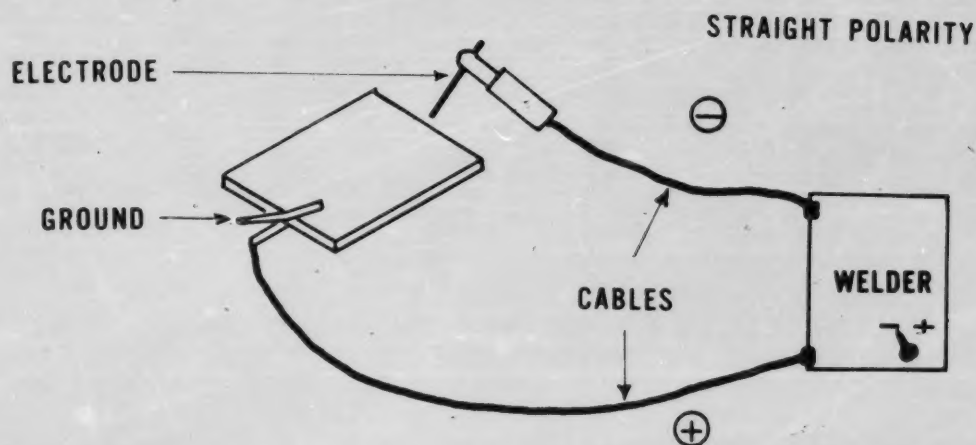
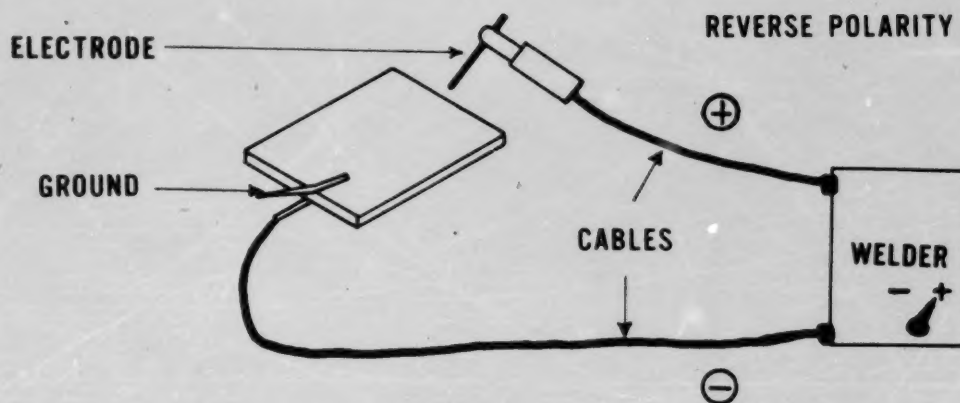


HELMET LENS INSTALLATION

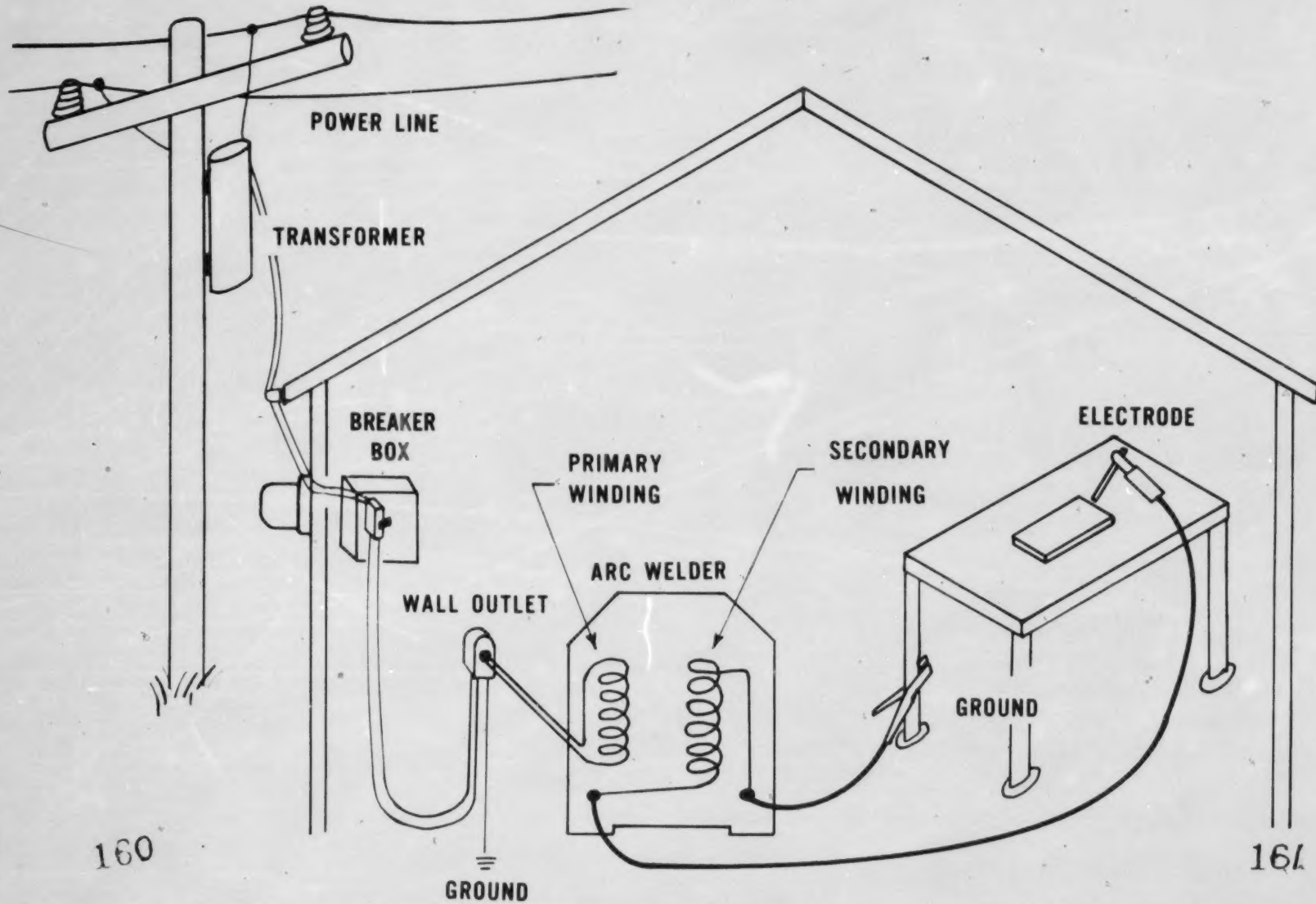


HELMET

DC POLARITY



AC WELDER



UNIT IV

INTRODUCTION TO SHIELDED METAL ARC WELDING

TEST--PART 1

1. Discuss briefly the history of shielded metal arc welding.

2. _____ a. A welding process that joins metals by heating them with an electric arc jumping from a coated electrode to the metal
- _____ b. The flow of electric current from the tip of the electrode to the metal being welded
- _____ c. A bar of flux-coated rod that is melted into the metal being welded, using heat from an electric arc
- _____ d. A material that is used in brazing and welding to allow the molten metal to fuse to the metal being welded, and to keep out impurities
- _____ e. The metal being welded
- _____ f. Metal added to the weld to produce buildup
- _____ g. The buildup of metal on the weld
- _____ h. The depression at the end of a weld
- _____ i. Distance from the end of the rod to the base metal being welded
1. AC (Alternating current) welder
2. DC (Direct current) welder
3. Crater
4. Base Metal
5. AWS
6. Shielded metal arc welding
7. Flux
8. Electrode
9. Amperage
10. Arc
11. Deposited metal
12. Filler metal
13. Arc length

- | | |
|---|------------------------------------|
| _____ j. A unit for welding in which current changes direction 120 times per second | 1. AC (Alternating current) welder |
| _____ k. A unit for welding in which the current travels in one direction only | 2. DC (Direct current) welder |
| _____ l. The measurement for electric current | 3. Crater |
| _____ m. American Welding Society | 4. Base Metal |
| | 5. AWS |
| | 6. Shielded metal arc welding |
| | 7. Flux |
| | 8. Electrode |
| | 9. Amperage |
| | 10. Arc |
| | 11. Deposited metal |
| | 12. Filler metal |
| | 13. Arc length |

UNIT IV

INTRODUCTION TO SHIELDED METAL ARC WELDING

TEST--PART 2

3. Identify three types of arc welders by filling in the correct term in each blank from the list below.

_____ a. A transformer type of welder producing alternating current

_____ b. A motor or engine-driven generator producing direct current

_____ c. A transformer rectifier producing either type of current

Carbon-arc welder

AC-DC welder

AC welder

DC welder

Oxyacetylene welder

4. Explain what each of the welding machine adjustments does to the heat of the welding process (a and b) and the direction of current flow (c and d).

a.

b.

c.

d.

5. Select special uses of the arc welder by answering YES to those of the following statements that are proper uses.

a. Cutting can be done with special rods

b. Brazing of cast iron

c. Hole piercing

d. Gauging or removing metal

e. Soldering

f. Beveling metal edges

6. Identify each of the parts of arc welding equipment by placing the number of the part in the blank to the left of the correct name.

a. Arc welder

b. Welding helmet

c. Leather gloves

d. Electrode holder

e. Welding leads

f. Chipping hammer

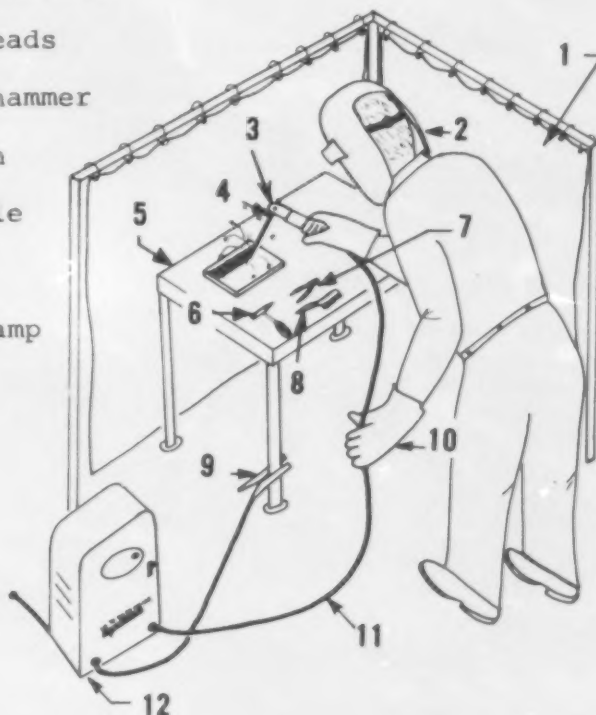
q. Wire brush

h. Metal table

i. Electrode

j. Ground clamp

k. Pliers



7. Select the proper lens and sequence for installation in the welding helmet by placing each of the following in the appropriate blanks.

Hold-down clamp

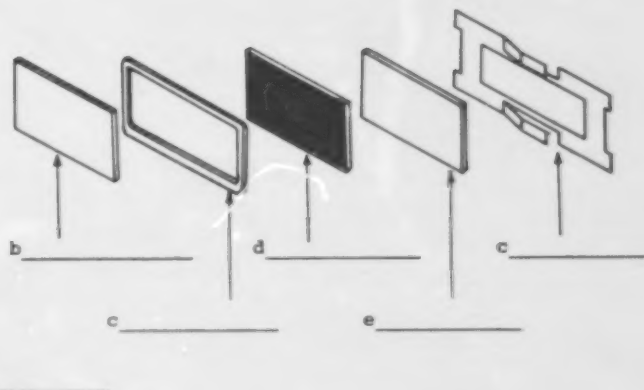
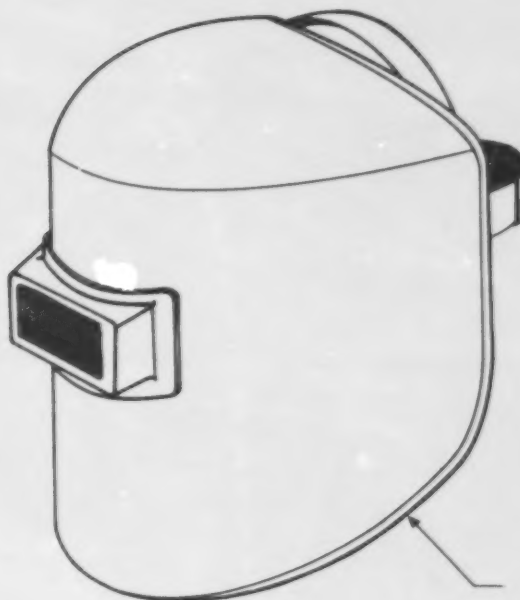
Clear plastic lens

Helmet

Rubber gasket

Filter lens

Clear plastic lens



UNIT IV

INTRODUCTION TO SHIELDED METAL ARC WELDING

TEST--PART 3

8. Select the proper safety procedures involving hazardous areas of arc welding by answering true or false to each of the statements below.
- ☐ a. The welder does not need to be grounded to be safe.
 - ☐ b. The welder should be kept in a cool damp area.
 - ☐ c. Since the welding cables are armored, it does not hurt to run over them with the welding dolly.
 - ☐ d. When welding, do not stand on wet surfaces or in water.
 - ☐ e. Use electrode holders as long as possible, even when cracked, because they are expensive.
 - ☐ f. Wear leather gloves that are in good condition.
 - ☐ g. The face and eyes should be covered with an arc welding helmet or shield.
 - ☐ h. Ultraviolet and infrared rays will only burn the skin of certain people.
 - ☐ i. A verbal warning should be given to all persons in the area before striking an arc.
 - ☐ j. Cracks in a helmet will not be any problem if the lens are good.
 - ☐ k. Replace any cracked helmet lens.
 - ☐ l. Oxyacetylene goggles may be worn when arc welding.
 - ☐ m. Wear high top shoes.
 - ☐ n. Low top shoes may be worn if pants with cuffs are worn.
 - ☐ o. Shirts should have long sleeves and button-up collars.

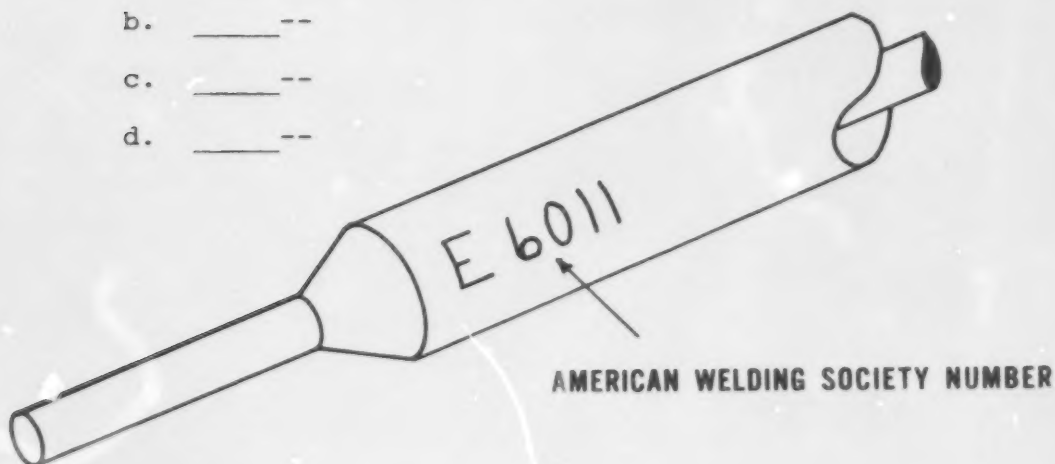
- _____p. Wear welding gloves of leather.
- _____q. Leather welding sleeves should be worn when available.
- _____r. Leather aprons should be worn when available.
- _____s. Safety glasses are not necessary if you shield your eyes with your hand when chipping or cleaning welds.
- _____t. There is no danger when welding galvanized metal.
- _____u. Fans or adequate ventilation should be provided to remove toxic gases.
- _____v. Avoid welding on containers or metals that have contained chemicals or been painted.
- _____w. Sparks will not ignite oily rags.
- _____x. Do not weld on containers that have held a combustible substance.
- _____y. Handle hot metal with leather gloves.
- _____z. Stand to one side when dropping hot metal into a cooling vat because hot steam will then be given off.
- _____Aa. Molten metal splatter usually cools quickly and will not burn the skin.

UNIT IV

INTRODUCTION TO SHIELDED METAL ARC WELDING

TEST--PART 4

9. Point out the types of welding electrodes by placing a "✓" in front of each of the following electrode types.
- ____ a. Mild steel
 - ____ b. Low hydrogen
 - ____ c. High hydrogen
 - ____ d. Stainless steel
 - ____ e. Brass
 - ____ f. Cast iron
 - ____ g. Hard surfacing
 - ____ h. Copper
 - ____ i. Non-ferrous
10. Identify each of the American Welding Society specifications on the electrode below.
- a. ____--
 - b. ____--
 - c. ____--
 - d. ____--



11. List two factors to remember in determining electrode sizes.

a.

b.

12. Name the purposes of flux.

a.

b.

c.

d.

e.

f.

g.

UNIT IV

INTRODUCTION TO SHIELDED METAL ARC WELDING

TEST--PART 5

13. Identify each of the following positions by labeling each of the illustrations with one of the following:

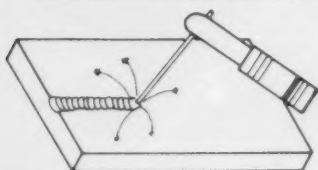
Horizontal

Overhead

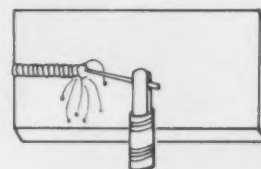
Vertical

Flat

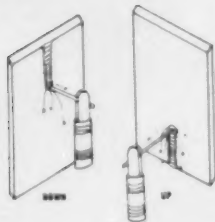
a. _____



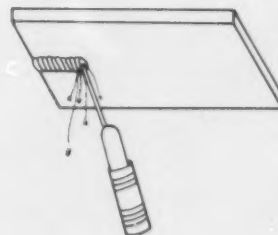
b. _____



c. _____



d. _____



14. Identify each of the weld joints by labeling each of the illustrations with one of the following:

Edge joint

Butt joint

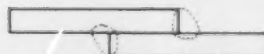
Tee joint

Lap joint

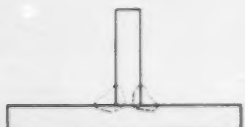
a. _____



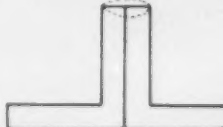
b. _____



c. _____



d. _____

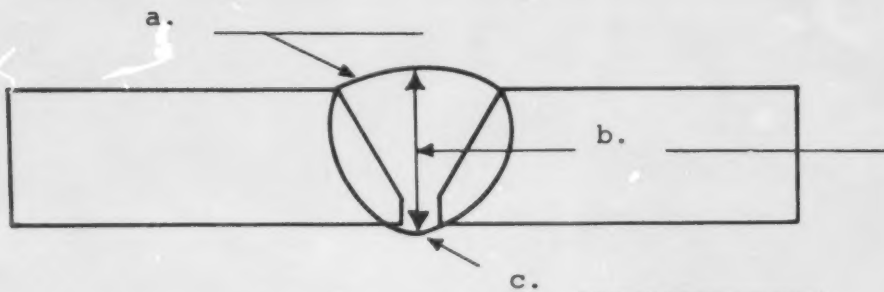


15. Identify each of the parts of a fillet weld by labeling each with one of the following:

Throat

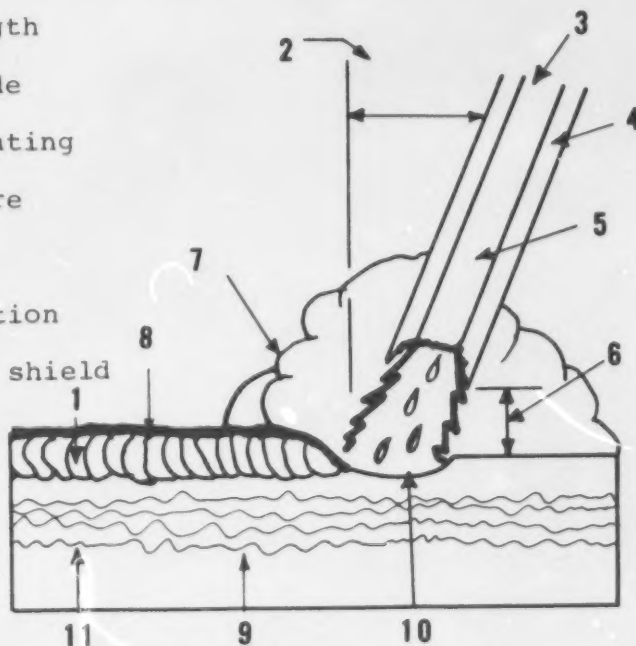
Root

Face



16. Identify each of the terms associated with the welding process by placing the number pointing to each of the parts to the left of the correct term.

- ___ a. Weld
- ___ b. Slag
- ___ c. Base metal
- ___ d. Angle of electrode
- ___ e. Arc length
- ___ f. Electrode
- ___ g. Flux coating
- ___ h. Wire core
- ___ i. Crater
- ___ j. Penetration
- ___ k. Gaseous shield



UNIT IV

INTRODUCTION TO SHIELDED METAL ARC WELDING

ANSWERS TO TEST

PART 1

1. Discussion should include:
- a. Welding with an electric arc was developed at the end of the 19th century.
 - b. Electric arc welding was first used to join parts of a storage battery.
 - c. Use of the arc welder failed in its early history because people were uninformed of its possibilities.
 - d. Carbon arc welding was patented by a Russian inventor.
 - e. Coatings were added to electrodes to keep out oxygen and nitrogen and to form a stronger weld.
2. 6 a. 12 f. 1 j.
 10 b. 11 g. 2 k.
 8 c. 3 h. 9 l.
 7 d. 13 i. 5 m.
 4 e.

PART 2

3. AC welder a. DC welder b. AC-DC welder c.
4. a. Produces more heat
b. Produces less heat
c. Allows current to flow from base metal to electrode
d. Allows current to flow from electrode to base metal

5. yes a. yes d.
 b. e.
yes c. yes f.

6. 12 a. 11 e. 4 i.
2 b. 6 f. 9 j.
10 c. 8 g. 7 k.
3 d. 5 h.

7. a. Helmet
b. Clear plastic lens
c. Rubber gasket
d. Filter lens
e. Clear plastic lens
f. Hold-down clamp

PART 3

8. False a. False j. False s.
False b. True k. False t.
False c. False l. True u.
True d. True m. True v.
False e. False n. False w.
True f. True o. True x.
True g. True p. False y.
False h. True q. True z.
True i. True r. False Aa.

14. a. Butt joint

c. Tee joint

b. Lap joint

d. Edge joint

15. a. Face

b. Throat

c. Root

16. 1 a.

4 g.

8 b.

5 h.

9 c.

10 i.

2 d.

11 j.

6 e.

7 k.

3 f.

UNIT V

WELDING JOINTS AND POSITIONS

UNIT OBJECTIVE

After completion of this unit, the student will be able to use the correct welding terminology in pointing out the factors involved in producing a quality arc weld. The student will be able to prepare and lay a V-butt arc weld, run a continuous bead without breaking an arc, and weld in the various welding positions. This knowledge will be evidenced through demonstration and by satisfactorily completing the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student will be able to:

1. Match the terms associated with arc welding to the correct definitions.
2. Point out the factors to consider when setting welder amperage.
3. Select the factors one must consider when selecting electrodes.
4. Determine the factors that affect the quality of a weld.
5. Select the methods of striking an arc.
6. Identify proper weave patterns.
7. List the reasons for fusing one bead to another.
8. Pick out the correct reasons to remove slag.
9. Demonstrate the ability to:
 - a. Start, stop, and restart the bead.
 - b. Make a pad in the flat position.
 - c. Make a pad in the horizontal position.
 - d. Make a pad in the vertical position.
 - e. Prepare metal to make a V-butt weld joint.

V-2

- f. Make a V-butt weld.
- g. Run a continuous bead.

UNIT V
WELDING JOINTS AND POSITIONS

SUGGESTED ACTIVITIES

I. Instructor

- A. Provide the students with objective sheet.
- B. Provide the students with information and job sheets.
- C. Design practical small projects students can make while learning to weld.
- D. Make transparencies.
- E. Discuss unit and specific objectives.
- F. Discuss information and job sheets.
- G. Give test.

II. Student

- A. Read objective.
- B. Study information sheets and ask questions.
- C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objective sheet
- B. Information sheets
 - 1. Information Sheet #1--Arc Welding Terminology
 - 2. Information Sheet #2--Preparing to Weld
 - 3. Information Sheet #3--Making the Weld

C. Transparency masters

TM-1--Proper and Improperly Formed Beads

D. Job sheets

1. Job Sheet #1--Start, Stop, and Restart a Bead
2. Job Sheet #2--Make a Pad in the Flat Position
3. Job Sheet #3--Make a Pad in the Horizontal Position
4. Job Sheet #4--Make a Pad in the Vertical-Up Position
5. Job Sheet #5--Prepare Metal to Make a V-Butt Weld Joint
6. Job Sheet #6--Make a V-Butt Weld
7. Job Sheet #7--Run a Continuous Bead

II. References

- A. Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. Modern Welding. South Holland, Illinois: The Goodheart-Wilcox Co., 1970
- B. Pender, James A. Welding. Toronto, New York: McGraw-Hill Book Company, 1968.

UNIT V

WELDING JOINTS AND POSITIONS

INFORMATION SHEET #1--ARC WELDING TERMINOLOGY

I. Terms and definitions

- A. Fusion--Joining two pieces of metal by heating the adjoining edges to the melting point, allowing them to flow together, and then cool
- B. Penetration--The depth to which the heat of the arc melts the metal during welding
- C. Face of weld--The exposed surface of a fusion weld
- D. Root of weld--The bottom or part of a weld farthest from the application of weld heat
- E. Horizontal position weld--A weld laid on a horizontal seam on a piece of metal
- F. Vertical position weld--A weld laid on a vertical seam on a piece of metal
- G. Pads--Metal plates which have beads running side by side and slightly overlapping where the beads form a solid mass
- H. Porousness--Weld metal that has gas pockets in the weld area
- I. Undercut--The part of the weld crater left unfilled because of incorrect electrode movement or too much amperage
- J. Pinhole--A small hole in the weld metal caused by trapped gases
- K. Slag deposits--A non-metallic porous material in weld metal
- L. Tack weld--A short weld made to hold parts in place until the final weld can be made
- M. Puddle--The area on a weld where the metal is molten from the heat of the arc

- N. Weave--The movement of the electrode during welding to provide the proper width and buildup
- O. Whipping--A term applied to a rapid movement of the electrode to prevent overheating the weld area and allowing the molten metal to solidify
- P. Rate of travel--The speed the electrode is moved across the weld area

UNIT V

WELDING JOINTS AND POSITIONS

INFORMATION SHEET #2--PREPARING TO WELD

II. Factors to consider when setting welder amperage

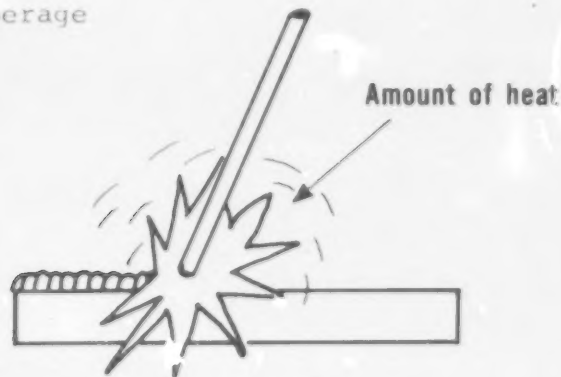
- A. Length and size of welding cables
- B. Thickness of base metal
- C. Welding technique
- D. Diameter of electrode
- E. Type of welder
- F. Polarity on a DC welder
- G. Type of welding joint or position

III. Factors to consider when selecting electrodes

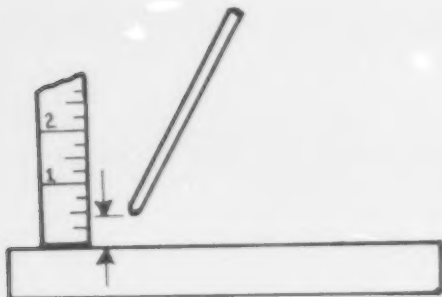
- A. Welding position
- B. Strength of weld desired
- C. Type of base metal
- D. Welding current (AC or DC)
- E. Thickness of base metal at weld area
- F. Design of the weld joint

IV. Factors that affect the quality of a weld

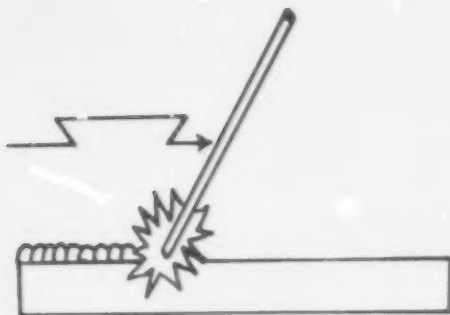
- A. Amperage



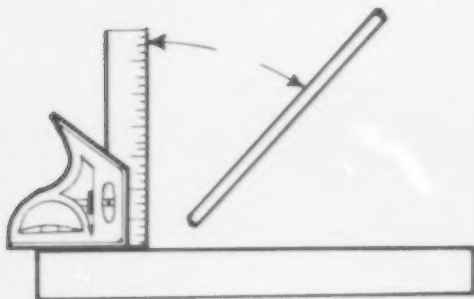
B. Arc length



C. Rate of travel



D. Angle of electrode



UNIT V

WELDING JOINTS AND POSITIONS

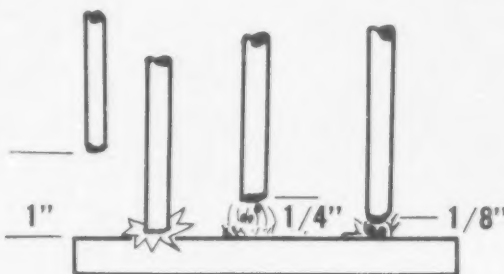
INFORMATION SHEET #3--MAKING THE WELD

V. Methods of striking an arc

A. Scratching

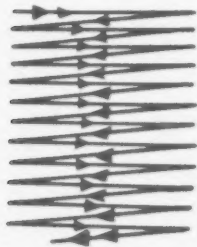


B. Tapping

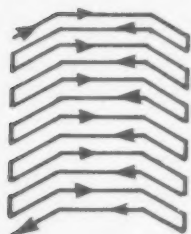


VI. Weave patterns

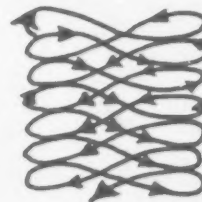
A.



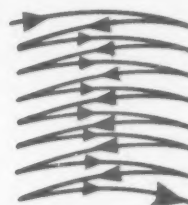
B.



C.



D.



VII. Reasons for fusing one bead to another in a weld

- A. Makes weld stronger
- B. Improves penetration
- C. Improves the appearance

VIII. Reasons to remove slag

- A. Allows better fusion of other beads
- B. Prevents slag deposits from forming in a bead
- C. Improves appearance of a weld

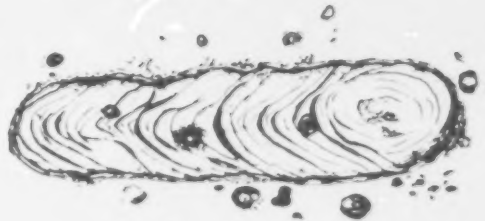
PROPER AND IMPROPER FORMED BEADS



A GOOD BEAD



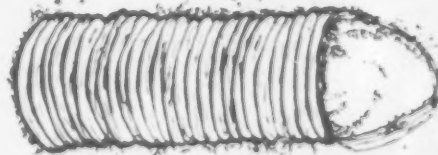
AMPERAGE TOO LOW



AMPERAGE TOO HIGH



SPEED TOO FAST



SPEED TOO SLOW

UNIT V

WELDING JOINTS AND POSITIONS

JOB SHEET #1--START, STOP, AND RESTART THE BEAD

I. Tools, equipment, and materials required

- A. An arc welder and accessories
- B. Gloves
- C. Helmet
- D. Safety glasses
- E. Chipping hammer
- F. Wire brush
- G. Pliers or vise grips
- H. Mild steel plate--3/8 x 6 x 6 inches
- I. 1/8 inch E6013 electrodes
- J. Coveralls

II. Procedure

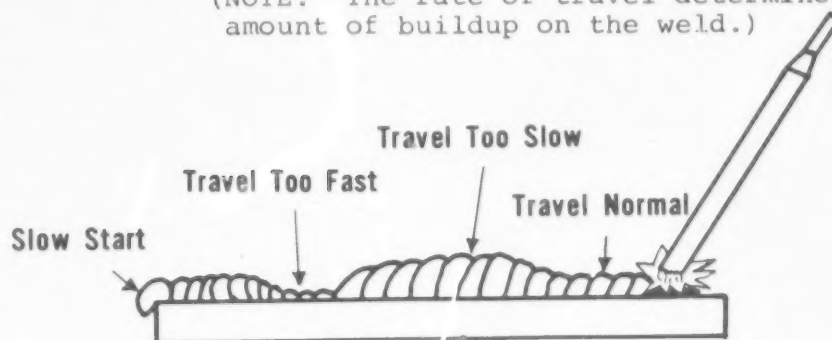
A. To start a bead

- 1. Put on coveralls, helmet, and gloves.
- 2. Adjust welding machine to approximate amperage setting.
- 3. Prepare metal and equipment for welding.
- 4. Sit or stand in a comfortable position.
- 5. Hold the electrode perpendicular to the plate where the weld is to be started.
- 6. Slant electrode 10° to 15° in the direction of travel.



7. Lower the electrode and lightly strike with a match striking motion the edge of the plate.
8. Raise the electrode as the arc starts to pre-heat the metal.
9. When the metal begins melting, lower the electrode to form the correct arc length.
10. Move the electrode in a circular pattern to obtain the desired width of bead.
11. When the desired molten puddle forms, move the electrode slowly down the area to be welded using one of the weave patterns.

(NOTE: The rate of travel determines the amount of buildup on the weld.)



B. To stop a bead

1. When the desired length of weld is reached, return the electrode to a perpendicular position.
2. Lower electrode slightly to shorten arc.
3. Move the electrode back and forth in the crater to form the desired bead width and buildup.
4. Raise the electrode quickly to break the arc.

C. To restart a bead

1. Chip slag and clean with a wire brush.
2. Strike an arc about 1/2 inch in front of the weld stopping point.

3. Move the arc quickly to the center of the crater.
4. When the proper buildup is reached, continue the weave pattern maintaining the proper travel and bead width.
5. When the desired weld length is reached, stop the bead.

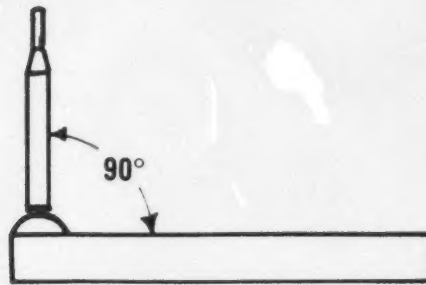
UNIT V

WELDING JOINTS AND POSITIONS

JOB SHEET #2--MAKE A PAD IN THE FLAT POSITION

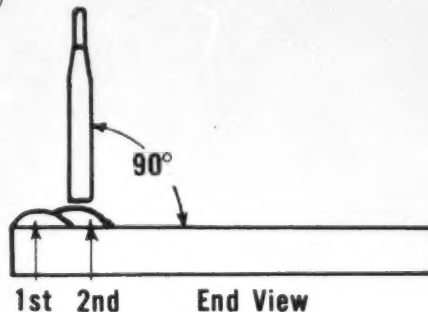
- I. Tools, equipment, and materials required
 - A. An arc welder and accessories
 - B. Gloves
 - C. Helmet
 - D. Safety glasses
 - E. Chipping hammer
 - F. Wire brush
 - G. Pliers or vise grips
 - H. Mild steel plate--3/8 x 6 x 6 inches
 - I. 1/8 inch E6013 electrodes
 - J. Coveralls
 - K. Cooling vat
- II. Procedure
 - A. Put on coveralls, helmet, and gloves.
 - B. Adjust welding machine to approximate amperage setting.
 - C. Prepare metal and equipment for welding.
 - D. Sit or stand in a comfortable position.
 - E. Strike an arc at the end of the plate near either edge.
 - F. Run a bead parallel to the edge for the entire length of the plate.

(NOTE: Be careful to not burn off the edge of the plate.)

**End View**

- G. After completing the first weld, cool the metal in the cooling vat and inspect it for faults.
 - H. Remove all slag from the bead.
- (NOTE: Some faults to check for are pinholes, crater holes, slag deposits, or poor stops and starts.)
- I. Make necessary adjustments to the amperage if the first weld bead indicates incorrect heat.
 - J. Run a bead in the opposite direction of the first bead and overlapping it about one-third of its width.

(NOTE: The beads should be fused or melted together to become one solid piece without valleys between them.)



- K. Continue running beads across the metal, changing directions with each new bead.
 - L. Clean and inspect each bead to make necessary welding machine adjustments and welding technique improvements.
- (NOTE: Beads should improve in appearance as the pad is welded.)
- M. When the pad is filled with beads, clean and turn in the beads to the instructor for grading.

UNIT V

WELDING JOINTS AND POSITIONS

JOB SHEET #3--MAKE A PAD IN THE HORIZONTAL POSITION

I. Tools, equipment, and materials required

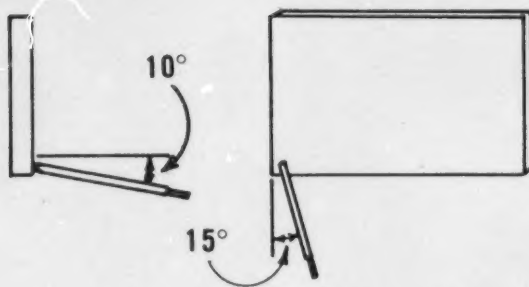
- A. An arc welder and accessories
- B. Gloves
- C. Helmet
- D. Safety glasses
- E. Chipping hammer
- F. Wire brush
- G. Pliers or vise grips
- H. Mild steel plate--3/8 x 6 x 6 inches
- I. 1/8 inch E6011 electrode
- J. Coveralls
- K. Cooling vat

II. Procedure

- A. Put on coveralls, helmet, and gloves
- B. Adjust welding machine to approximate amperage setting.
- C. Prepare metal and equipment for welding.

(NOTE: Metal may need to be tack welded to the table in a verticle position.)

- D. Sit or stand in a comfortable position.
- E. Hold the electrode 10° to 15° in the direction of travel and angled 5° to 10° below the bottom edge of the plate where the bead will be laid.

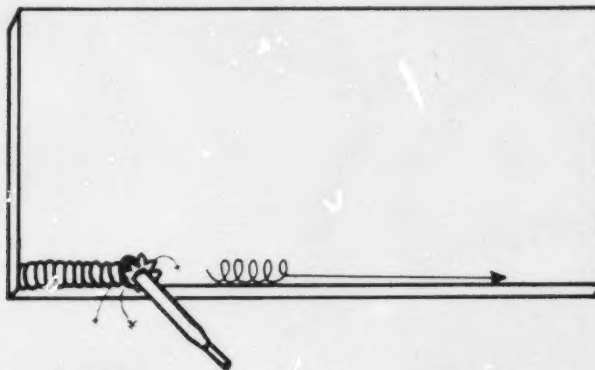


- F. Strike an arc and use a whipping technique to keep the molten metal from sagging or running off.

(NOTE: When using the whipping technique with a weave pattern on a horizontal weld, the electrode is held at the top edge of the weld puddle slightly longer than at the bottom edge.)

- G. Run a bead across the bottom edge of the plate.

(NOTE: Keep the bead up on the plate so it does not run off the edge.)



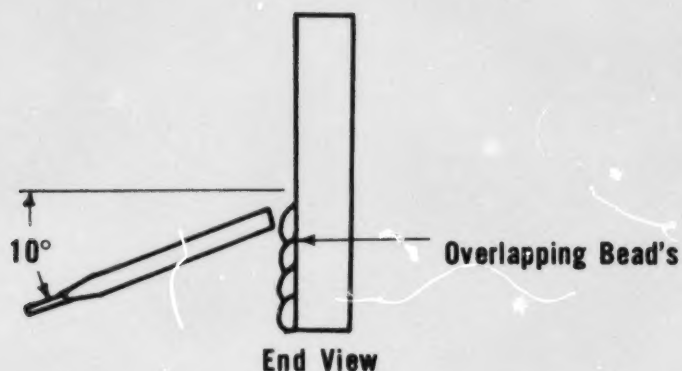
- H. When the bead is completed, cool and clean the weld.

- I. Inspect the weld for faults.

(NOTE: Some faults to check for are pinholes, crater holes, slag deposits, or poor stops and starts.)

- J. Make necessary adjustments in the amperage setting if the weld bead indicates incorrect heat.

- K. Continue running beads across the plate changing directions each pass and overlapping each previous bead one-third of its width.



- L. Clean and inspect each bead and make necessary machine adjustments or welding technique improvements.

(NOTE: Beads should improve in appearance as pad is welded.)

- M. When the pad is filled with beads, remove all slag and turn the pad into the instructor for grading.

UNIT V

WELDING JOINTS AND POSITIONS

JOB SHEET #4--MAKE A PAD IN THE VERTICAL-UP POSITION

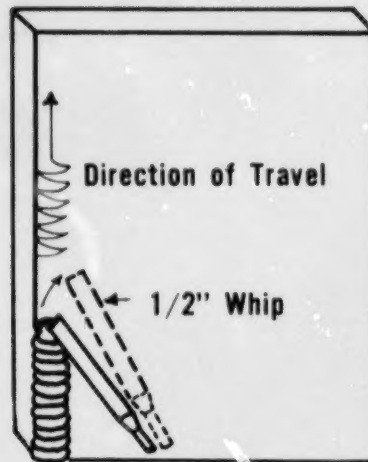
I. Tools, equipment, and materials required

- A. An arc welder and accessories
- B. Gloves
- C. Helmet
- D. Safety glasses
- E. Chipping hammer
- F. Wire brush
- G. Pliers or vise grips
- H. Mild steel plate-- $3/8 \times 6 \times 6$ inches
- I. $1/8$ inch E6011 electrode
- J. Coveralls

II. Procedure

- A. Put on coveralls, helmet, and gloves.
- B. Adjust welding machine to approximate amperage setting.
- C. Prepare metal and equipment for welding.
(NOTE: Metal should be tack welded to the table in a vertical position.)
- D. Sit or stand in a comfortable position.
- E. Slant electrode 10° to 15° below the bottom edge of the plate.





- F. Strike an arc and begin welding upward on the plate.
- G. Whip the end of the electrode in and out of the weld puddle to prevent run-off during the weld pattern.
- H. Move the bead to the top edge of the plate, continuing the welding technique the entire length.
- I. After completing the bead, cool and clean the bead.
- J. Inspect the bead for faults.
(NOTE: Some faults to check for are undercut, pinholes, run-off, slag deposits, and poor starts and stops.)
- K. Make necessary adjustments in the amperage setting if the weld bead indicates incorrect heat.
- L. Continue running beads, overlapping each previous bead 1/3 of its width.



- M. Clean and inspect each bead and make necessary machine adjustments or welding technique improvements.

(NOTE: Beads should improve in appearance as pad is welded.)

- N. When the pad is filled with beads, clean and turn in the beads to the instructor for grading.

UNIT V

WELDING JOINTS AND POSITIONS

JOB SHEET #5--PREPARE METAL TO MAKE A V-BUTT WELD JOINT

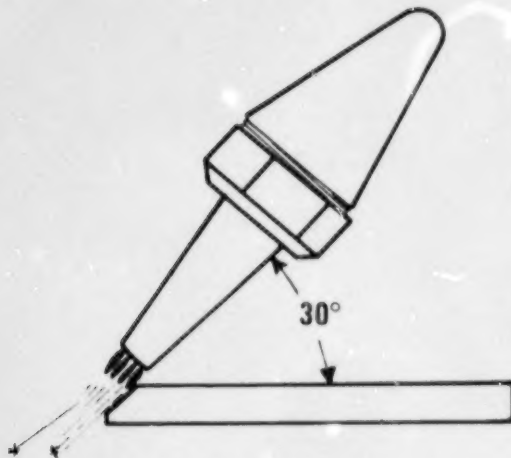
I. Tools, equipment, and materials required

- A. Oxyacetylene cutting torch unit
- B. Fling lighter
- C. Cutting goggles
- D. Chipping hammer
- E. Safety glasses
- F. Coveralls
- G. Gloves
- H. Bench or pedestal grinder
- I. Mild steel plate-- $3/8$ x 6 x 6 inches
- J. Cutting table
- K. Soapstone
- L. Try square
- M. Pliers or visegrips

II. Procedure

- A. Put on coveralls, cutting goggles, and gloves.
- B. Set up oxyacetylene cutting torch unit.
- C. Layout a line 3 inches from one edge of the plate with soapstone and try square.
- D. Cut the plate along the soapstone mark.
- E. Cool the metal and chip off the slag.
(CAUTION: Wear safety glasses.)
- F. Lay out lines on each of the plates about $1/8$ inch from the edge along the 6-inch side.

- G. Cut about a 30° bevel along the soapstone lines.



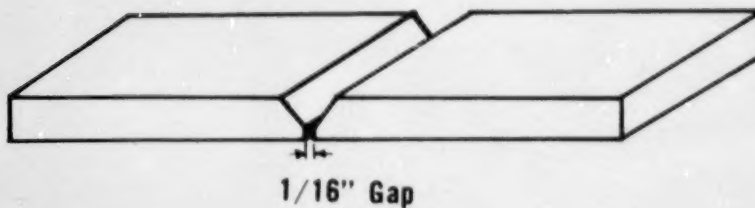
- H. Chip off all slag.

(CAUTION: Wear safety glasses.)

- I. Grind the torch cut edges straight and level.

- J. Place the metal on the table for tack welding.

(NOTE: A small gap on thick plate will allow a weld to penetrate further.)



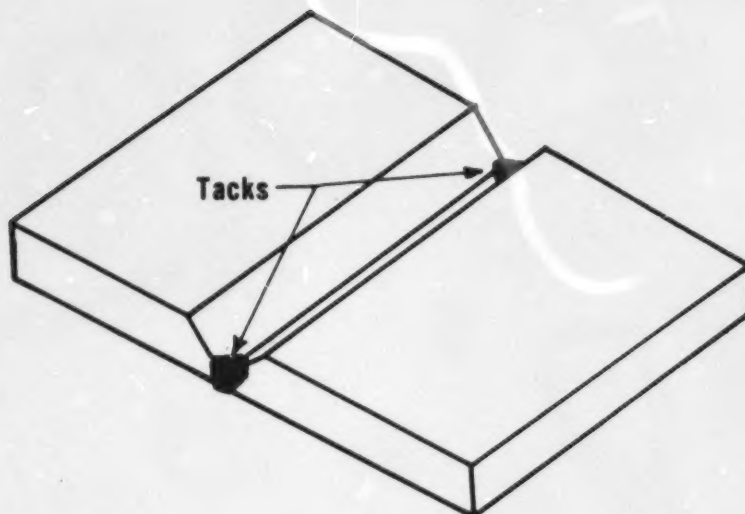
UNIT V

WELDING JOINTS AND POSITIONS

JOB SHEET #6--MAKE A V-BUTT WELD

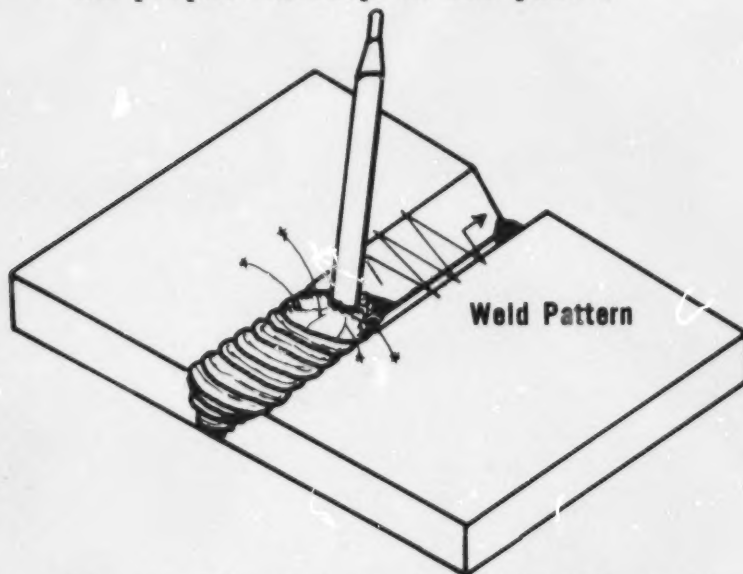
- I. Tools, equipment, and materials
 - A. An arc welder and accessories
 - B. Gloves
 - C. Helmet
 - D. Safety glasses
 - E. Chipping hammer
 - F. Wire brush
 - G. Pliers or vise grips
 - H. Mild steel plate--2 3/8 x 3 x 6 inches beveled plate
 - I. 5/32 inch E6011 electrode
 - J. Coveralls
- II. Procedure
 - A. Put on coveralls, helmet, and gloves
 - B. Adjust welding machine to approximate amperage setting.
 - C. Prepare metal and equipment for welding.
 - D. Sit or stand in a comfortable position.
 - E. Space metal plates 1/16 inch apart.
 - F. Tack weld the plates at both ends.
 - G. Chip slag from tack welds.

(See illustration on next page.)



H. Weld pieces, using a single pass weld.

(NOTE: Use as many rods as necessary to produce the proper buildup in one pass.)



I. Clean weld and inspect for buildup, slag deposits, pinholes, and poor starts and stops.

J. Turn in weld to the instructor for grading.

UNIT V

WELDING JOINTS AND POSITIONS

JOB SHEET #7--RUN A CONTINUOUS BEAD

I. Tools, equipment, and materials required

- A. An arc welder and accessories
- B. Gloves
- C. Helmet
- D. Safety glasses
- E. Chipping hammer
- F. Wire brush
- G. Pliers or vise grips
- H. Mild steel plate--1/4 x 4 x 4 inches
- I. Black pipe nipple--4 inches long, 2 to 3 inches in diameter
- J. 1/8 inch E6013 electrode
- K. Coveralls
- L. C-clamp
- M. Cooling vat

II Procedure

- A. Put on coveralls, helmet, and gloves.
- B. Adjust welding machine to approximate amperage setting.
- C. Prepare plate and pipe for welding.

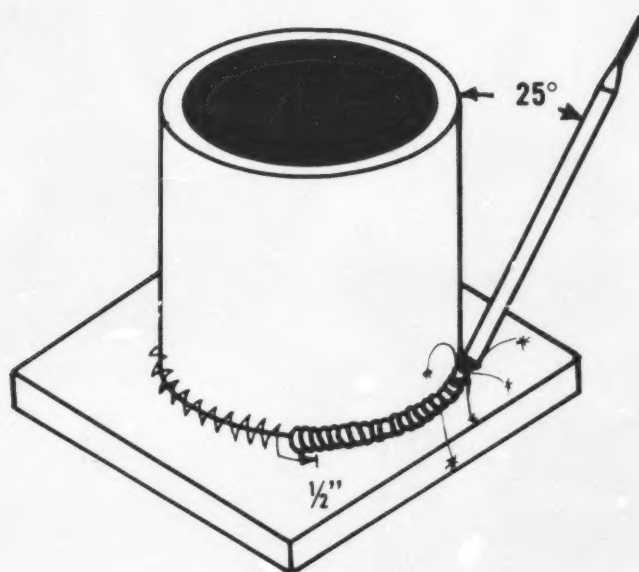
(NOTE: Pipe should be centered on plate and held in place with a c-clamp.)



- D. Tack weld nipple to plate and remove c-clamp.
- E. Chip slag from tack welds.
(CAUTION: Wear safety glasses.)
- F. Stand in a comfortable position so that all areas to be welded can be seen.
- G. Hold electrode 25° from the nipple and begin weld
- H. Weld completely around the pipe without breaking the arc.

(NOTE: Weld past the start of the weld 1/2 inch.)

(See illustration on next page)



- I. Cool and clean the weld.
- J. Inspect the weld for undercut, slag deposits, pinholes, and proper buildup.
- K. Turn in the weld to the instructor for grading.

(NOTE: The product of this job sheet may be used as on electrode holder.)

UNIT V
WELDING JOINTS AND POSITIONS

TEST--PART 1

1. Match the terms associated with arc welding to the correct definition by placing the correct number to the left of the letter.

- | | |
|--|-----------------------------|
| _____ a. Joining two pieces of metal by heating the adjoining edges to the melting point, allowing them to flow together, and then cooling | 1. Tack weld |
| _____ b. The depth the heat of the arc melts the metal during welding | 2. Horizontal position weld |
| _____ c. The exposed surface of a fusion weld | 3. Porousness |
| _____ d. The bottom or part of a weld farthest from the application of weld heat | 4. Vertical position weld |
| _____ e. A weld laid on a horizontal seam on a piece of metal | 5. Fusion |
| _____ f. A weld laid on a vertical seam on a piece of metal | 6. Puddle |
| _____ g. Metal plates which have beads running side by side and slightly overlapping so that the beads form a solid mass | 7. Rate of travel |
| _____ h. Weld metal that has gas pockets in the weld area | 8. Weave |
| | 9. Penetration |
| | 10. Pinhole |
| | 11. Pads |
| | 12. Face of weld |
| | 13. Undercut |
| | 14. Root of weld |
| | 15. Whipping |
| | 16. Slag deposits |

- | | |
|--|-----------------------------|
| _____ i. The part of the weld crater left unfilled because of incorrect electrode movement or too much amperage | 1. Tack weld |
| _____ j. A small hole in the weld metal caused by trapped gases | 2. Horizontal position weld |
| _____ k. A non-metallic porous material trapped in weld metal | 3. Porousness |
| _____ l. A short weld made to hold parts in place until the final weld can be made | 4. Vertical position weld |
| _____ m. The area on a weld where the metal is molten from the heat of the arc | 5. Fusion |
| _____ n. The movement of the electrode during welding to provide the proper width and buildup | 6. Puddle |
| _____ o. A term applied to a rapid movement of the electrode to prevent overheating the weld area and allow the molten metal to solidify | 7. Rate of travel |
| _____ p. The speed the electrode is moved across the weld area | 8. Weave |
| | 9. Penetration |
| | 10. Pinhole |
| | 11. Pads |
| | 12. Face of weld |
| | 13. Undercut |
| | 14. Root of weld |
| | 15. Whipping |
| | 16. Slag deposits |

UNIT V

WELDING JOINTS AND POSITIONS

TEST--PART 2

2. Point out the factors to consider when setting welder amperage by placing a "✓" in front of each of the following phrases that must be considered.

- ☐ a. Length and size of welding cables
- ☐ b. Length of electrode
- ☐ c. Thickness of base metal
- ☐ d. Welding technique
- ☐ e. Diameter of electrode
- ☐ f. Type of welding gloves
- ☐ g. Type of welder
- ☐ h. Polarity of a DC welder
- ☐ i. Type of welding joint or position

3. Select the factors one must consider when selecting electrodes by answering YES or NO to each of the following phrases:

- ☐ a. Welding position
- ☐ b. Type of ventilation system in the shop
- ☐ c. Strength of weld desired
- ☐ d. Type of base metal
- ☐ e. Welding current (AC or DC)
- ☐ f. Thickness of base metal at weld area
- ☐ g. Design of weld joint
- ☐ h. Amount of moisture in the air

4. Determine the factors that affect the quality of a weld by underlining the following phrases that affect a weld's quality.
- a. Amperage
 - b. Arc length
 - c. Rate of travel
 - d. Thickness of metal
 - e. Angle of electrode

UNIT V
WELDING JOINTS AND POSITIONS

TEST--PART 3

5. Select the methods of striking an arc by placing the correct word from the list by the illustration representing each.

Dragging

Tapping

Scratching

Slapping

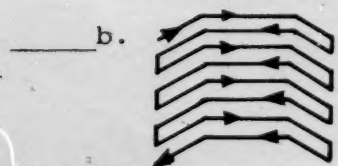
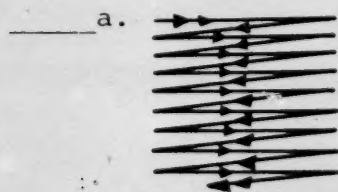


a. _____

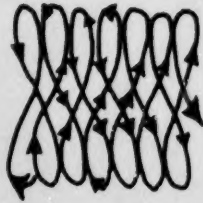


b. _____

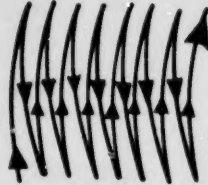
6. Identify the proper weave patterns by placing a "✓" in front of each of the usable patterns.



____ d.



____ e.



7. List three reasons for fusing one bead to another in a weld.

a.

b.

c.

8. Pick out the correct reasons to remove slag by placing a check in front of each.

____ a. Allows better fusion of other beads

____ b. Gives welder time to rest between welds

____ c. Prevents slag deposits from forming in a bead

____ d. Improves appearance of a weld

9. Demonstrate the ability to:

a. Start, stop, and restart the bead

b. Make a pad in the flat position

c. Make a pad in the horizontal position

d. Make a pad in the vertical-up position

e. Prepare metal to make a V-butt weld joint

f. Make a V-butt weld

g. Run a continuous bead

(NOTE: If these activities have not been accomplished prior to the test, ask the instructor when they should be completed.)

UNIT V
WELDING JOINTS AND POSITIONS

ANSWERS TO TEST--PART 1

- | | |
|--------------------|----------------|
| 1. <u> 5 </u> a. | <u> 13 </u> i. |
| <u> 9 </u> b. | <u> 10 </u> j. |
| <u> 12 </u> c. | <u> 16 </u> k. |
| <u> 14 </u> d. | <u> 1 </u> l. |
| <u> 2 </u> e. | <u> 6 </u> m. |
| <u> 4 </u> f. | <u> 8 </u> n. |
| <u> 11 </u> g. | <u> 15 </u> o. |
| <u> 3 </u> h. | <u> 7 </u> p. |

PART 2

- | | |
|--------------------|-----------------|
| 2. <u> ✓ </u> a. | <u> </u> f. |
| <u> </u> b. | <u> ✓ </u> g. |
| <u> ✓ </u> c. | <u> ✓ </u> h. |
| <u> ✓ </u> d. | <u> ✓ </u> i. |
| <u> ✓ </u> e. | |

- | | |
|--------------|--------|
| 3. a. Yes | e. Yes |
| b. No | f. Yes |
| c. Yes | g. Yes |
| d. Yes | h. No |

4. a, b, c, e

PART 3

5. a. Scratching
 b. Tapping

6. ☒ a.

☒ b.

☐ c.

☒ d.

☒ e.

7. a. Makes weld stronger

b. Improves penetration

c. Improves appearance

8. ☒ a.

☐ b.

☒ c.

☒ d.

9. Evaluated to the satisfaction of the instructor.